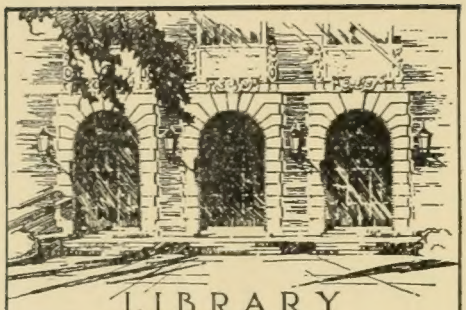

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PROCEEDINGS

OF THE

FIFTH ANNUAL CONVENTION

OF THE

American Railway Engineering and Maintenance of Way Association

HELD AT THE

AUDITORIUM HOTEL, CHICAGO, ILLINOIS

March 15, 16 and 17, 1904

VOLUME 5

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PROCEEDINGS

This Association is not responsible, as a body, for the opinions or views expressed by individual members.

TUESDAY, MARCH 15, 1904.

MORNING SESSION.

The meeting was called to order at 9:30 a. m. by the President, Mr. Hunter McDonald.

The President:—The first business in order is the reading of the Minutes of the last annual convention. As the Minutes have been printed and are in the hands of the members, unless there is objection, they will stand approved as printed.

The next business is the reports of the Secretary and Treasurer.

Secretary L. C. Fritch read the following reports:

REPORTS OF SECRETARY AND TREASURER.

To the Members of the Association:

The following report is respectfully submitted:

FINANCIAL STATEMENT.

Balance cash on hand at last annual convention		$3,783 42
Receipts during the year:		
Entrance fees	$ 590 00	
Dues	4,077 50	
Sale of Proceedings	1,438 71	
Sale of Bulletins and binding Proceedings for members	139 60	
Sale of Specifications	26 97	
Advertising	2,205 95	
Total receipts	$8,478 73	

Expenditures during the year:		
Printing	$4,616 16	
Postage and exchange	465 27	
Salaries	1,500 00	
Office equipment	7 40	
Office supplies	21 44	
Rents	385 00	
Annual meeting expenses	179 20	
Committee expenses	54 64	
Expressage on Proceedings	80 19	
Telegrams and telephone charges	12 97	
Light	13 59	
Total Expenditures	$7,335 86	
Balance to credit	1,122 87	1,122 87
Cash on hand date of this report		$4,906 29
Bills receivable:		
From Advertising	$1,248 50	
From sale of Proceedings	62 50	
From dues, etc	536 50	
Total bills receivable	$1,847 50	

MEMBERSHIP.

Membership at last annual convention		441
Members admitted during the year	55	
Members deceased during the year	9	
Withdrawals	12	
Members dropped for non-payment of dues	38	
Loss	4	4
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Mr. D. C. Shepard, of St. Paul, Minn., has been elected an honorary member by the Board of Direction.

The following members of the Association have died during the year: J. M. Clark, E. M. Collins, H. C. Draper, J. J. Frey, J. V. Goode, G. W. Gardner, Theo. D. Kline, Geo. S. Morison, R. H. Wight.

The President:—You have heard the reports of the Secretary and Treasurer. What will you do with them?

On motion of Mr. W. G. Besler (Central Railroad of New Jersey), the reports of the Secretary and Treasurer were adopted.

The President:—The next item in the order of business is the address of the President.

PRESIDENT'S ADDRESS.

At this our fifth annual convention it seems particularly appropriate that we look back and see how faithfully we have wrought, and there is no better way of doing it than by reading again the excellent address delivered by President Wallace at the opening of the first annual convention. It is hoped that all of you will look it up and read it. He has left

little for his successors to say regarding the general conduct of the affairs of the Association, but some of the details may be looked into with profit.

We are about to celebrate our wooden wedding. The first five years of our union have been productive of valuable results in many ways, and have promoted mutual acquaintance and understanding and, to some extent, freedom of expression. Like the newly wedded couple, we have yet much to learn about each other, the management of our household affairs and the training of the children. We must learn the tastes, capabilities and inclinations of the members, to the end that our committees may be made up of men who are specially fitted for the particular work assigned them.

The prime reason for our organized existence is the opportunity offered for interchange of views on matters in which we are interested and the benefits to ourselves and employers to be derived therefrom. Such interchange of views should not be confined to a few members who may perhaps be moved to speak or write, not from a profound knowledge of the subject, but because those who are better qualified to enlighten us remain silent. It is earnestly hoped that members will express themselves freely on all subjects in which they feel an interest and those whose experience gives weight to their words will not wait for an invitation to speak out. It is very gratifying to the committees to have their reports bring out full and interesting discussion, and disappointing to them if they fail to produce this result. As a general proposition, everybody loves a good listener, but if we all remain listeners, there will be none to love us.

We must learn how to outline the work of the committees, to the end that their reports may be exhaustive and conclusive. It is not expected that the reports shall be the final summation and end of the subject, as this would leave no room for improvement or further development, but it is desired that they shall compass the present knowledge of the subject and even go deeper than that when opportunity offers. The reports should express the combined judgment of the committee with regard to the practice which it expects the Association to approve, keeping always in view the fact that such approval is subject to revision as circumstances justify.

We must learn the necessity of avoiding, as far as possible, the resubmission, in committee reports, of matter which has already been published. It should be borne in mind that our Editor and Secretary very properly hesitate to edit the reports of committees. This should be carefully done by the committees themselves, reference being made, when possible, to volume and page for matter previously published. Such practice will save much expense in printing, as well as space in the Proceedings, for matter which is fresher. The practice has been to some extent unavoidable in the past, and will be, of course, at times necessary in the future.

We must learn to make our publications more attractive and their contents more readily accessible. Valuable suggestions have been received from members, and will no doubt have careful attention by the Board of Direction. It is hoped that during the coming year members will not forget that the Bulletin is always open to them for professional papers, discussions of reports, communications, and, in short, any matter of

interest, and they are especially reminded that, since it is likely that all reports presented at this convention will be published in the Proceedings, the Bulletin will need all the assistance it can get during the next year. We must keep faith with our advertisers.

The committees seek information from many sources, which is doubtless used to advantage in the preparation of their reports, but much of this is often cast aside when it has served its purpose. The careful selection and editing of this material by the committee, and its publication from time to time in the Bulletins, would furnish interesting reading. The final report need not repeat the matter thus published, but reference can be made to it by Bulletin number only, and such portions as the committee desires can be published with the final report in the Proceedings. Excellent examples of such contributions are those contained in Bulletin No. 1, "Locomotive Tonnage Rating, Southern Pacific Company," prepared by the late W. G. Curtis; Bulletin No. 41, "Notes on Structural Steel," submitted by the Committee on Iron and Steel Structures; Bulletin No. 45, "Classification of Maintenance of Way Expenses," by Walter G. Berg, submitted by the Committee on Records, Reports and Accounts; and in Bulletin No. 49, the paper on "Reduction of Gradient," by J. B. Berry, and submitted by the Committee on Roadway. The arrival of all of these papers was quite opportune, and their contents are a credit to the Association and authors.

There has been a marked improvement in the quality and makeup of the committee reports for this convention, and their early publication has already produced valuable written discussion and will no doubt result in verbal expressions well prepared and to the point. The thanks of the Association are due to the committees for their zealous work in its behalf.

The tendency for the organization of associations for specialists is rapidly increasing, and the time is not far distant when our relations with kindred bodies must be clearly established. Let us hope that they may be harmonious, if not of a closer nature.

No doubt a large number of our members will take an interest in the announcement of the committee on the International Engineering Congress, which appears in Bulletin No. 49. All American engineers have an interest in seeing this congress a success, and the co-operation of our membership is solicited.

The report of our Secretary shows our financial condition to be sound, but that we are about living up to our income. We need a larger membership and more advertisers. We can get the former by personal effort on the part of members, as there are a large number of eligible men who have not yet joined us. We can get the latter by making our Bulletin more attractive and increasing the circulation. It is to be regretted that, in spite of large accessions to our membership, we have made no substantial increase, on account of members being dropped for arrears of dues.

It is very gratifying to note that our work is being appreciated by the technical press and by the railroad companies. We have met on all sides such encouragement as should urge us to put forward our best efforts in the work we have undertaken, and we are greatly indebted to the

press for its good-will and to the railroad companies and our advertisers for substantial aid and comfort.

The work of our Secretary pro tem. speaks for itself. He has conducted with signal ability and without clerical aid the business affairs of the Association and a voluminous and important correspondence. He has arranged and proof read all the publications, leaving little to be done by the Editor save to give good advice and check his work, which duty has been willingly and conscientiously performed by Professor Pence. To both of them our thanks are due.

We will now proceed with the work for which we have assembled. Let us master the science of transacting a great deal of business thoroughly in a short space of time. The field for our investigations is broad, the subjects to be covered innumerable. We must increase the capacity of the mill rather than reduce the supply of grist, but keep the output always of the first quality.

The President:—Before taking up the work of the committees, the Board of Direction desires to call the attention of the convention to the general rules for the consideration and publication of committee reports. There are some of these rules that apply to the conduct of this convention, and the Board desires that the convention shall approve them before they are put into effect. They will be found on the second and third pages of the program, and the matter is before the convention for disposal. The chair takes it for granted that the membership is familiar with these rules. They have been published for seven or eight months, and perhaps it is not necessary to have them read at this time. Do not understand that we have any wish to shut off any discussion of the matter, but it may not be necessary to occupy the time of the convention in reading them. It has been suggested that perhaps Mr. Sullivan will open the discussion on these rules.

Mr. A. W. Sullivan (Illinois Central):—The rules which have been prepared by the Board of Direction for the consideration and publication of committee reports, as published on pages 2 and 3 of the program, represent the ideas of the Board of Direction as to the best method of procedure in the systematic disposition of business by the Association. They are submitted with the idea that a full consideration of the question by the Association may add to the completeness of the rules, may perfect them by suggestion and amendment, and make them more effective to serve the purpose intended. I would suggest that the rules be read, paragraph by paragraph, and the members proceed at once to their discussion and adoption.

The President:—It has been suggested that we proceed with the reading of the rules and discuss them as read. If there is no objection, that course will be followed. (See pp. 765, 766.)

The Secretary read the introduction to the rules and Rule No. 1.

The President:—You have heard Rule No. 1. What action will you take upon it?

On motion of Mr. C. Dougherty (Illinois Central), Rule No. 1 was adopted as read.

The Secretary read Rule No. 2.

The President:—You have heard Rule No. 2. What action will you take upon it?

On motion of Mr. J. A. Atwood (Pittsburg & Lake Erie), Rule No. 2 was adopted.

The Secretary read Rule No. 3.

The President:—You have heard Rule No. 3. If there is no objection, Rule No. 3 will be adopted.

The Secretary read Rule No. 4.

The President:—Is there any discussion of Rule No. 4? If not, it will be considered adopted.

The Secretary read Rule No. 5.

The President:—All in favor of Rule No. 5 say aye. It is adopted.

The Secretary read Rule No. 6.

Mr. G. A. Mountain (Canada Atlantic):—What does clause (b) mean, "referring remainder back to committee?" Is that referred back by the Board or by the convention?

The President:—By the convention.

Mr. Mountain:—It reads, "Adoption of a portion and referring remainder back to committee."

The President:—The convention may adopt a portion and refer the remainder back.

Mr. Walter G. Berg (Lehigh Valley):—I would ask what action will be taken in the case of a paper or report in the nature of information, a descriptive paper, under these heads? Does the adoption of a paper as submitted carry with it the official adoption by the convention, or does it simply mean it will be adopted and printed in the Proceedings? Is it not possible that a fourth item should be added to cover the receiving of a paper for printing, without any formal adoption?

The President:—Would that not come under (c), Mr. Berg?

Mr. Berg:—It would not in that case; it would not be referred back to a committee. I refer to a paper such as the President spoke of in his address, a paper giving information, an independent paper, or, let us say, a committee report which is more descriptive than the usual report and giving information only. Would not that be received, printed in the Proceedings, and further action stopped at that point? Of course, it could come under the first subdivision (a), "Adoption as submitted," but it might be more convenient to have a fourth subdivision to cover such papers, to be described as "Received as information."

The President:—I think that would be covered by (a) in Rule 5, "Reading by title." That would be sufficient to secure the publication of a report in the Proceedings, and does not require any further action by the convention.

Mr. W. W. Curtis (Consulting Engineer):—There is one feature in Rule 5 that I wish to call attention to. I fail to see how, without special action by the Association, there can be proper discussion on matters which

are included in the report but which are not included in the conclusions For instance, in the report of the Committee on Ties there is information which is properly a matter for discussion by the convention, but under Rule 5, which refers to reading by title, and reading, discussing and acting upon each conclusion separately, unless some member wishes to ask the convention to vote to take up each item in the body of the report separately, there is, as the rule is laid out, no provision whatever for discussion on matter not included in the conclusions. The same point applies to the remarks of Mr. Berg. I think he is right in saying that we may have matter presented which is not properly a matter for adoption, and if we use the word "adoption" in connection with it, it will be understood by the general public to be the adoption by or official sanction of the Association of the practice or methods described.

Mr. Berg:—In answer to the first point of the last speaker, does not reading by title bring a report before the convention for discussion? Does not that include discussion of the report?

The President:—Reading by title brings it before the convention, and then the question comes up, under Rule No. 6, as to what action we shall take.

Mr. Berg:—Reading it by title brings it before the convention and allows discussion on the paper.

The President:—Unquestionably.

Mr. Berg:—That would cover the point the gentleman just raised, and we could discuss general questions contained in any report.

The President:—The idea in providing for the reading of papers by title was in case we should lack time to consider all reports, we could, simply by reading them by title, overcome the provision in the rules that reports not acted upon should be excluded from the Proceedings. The object was to allow the publication of these reports in the Proceedings, although they had not been formally discussed.

Mr. Berg:—I move an addition to the items in Rule No. 6, as follows: (d) Receiving as information.

On motion of Mr. Besler, the motion was carried.

The President:—The question is on Rule No. 6. All in favor of Rule No. 6 as amended will say aye. (Carried.)

The Secretary read Rule No. 7.

The President:—Is there any discussion on Rule No. 7? If not, all in favor of the rule will say aye. (The rule was adopted.)

The Secretary read Rule No. 8.

The President:—You have heard Rule No. 8. Is there any discussion upon it?

Mr. H. J. Slifer (Chicago, Rock Island & Pacific):—What about additional remarks? Will speakers be permitted to add to their remarks?

The President:—Unquestionably, under the head of "Written Discussion."

Mr. Slifer:—Under the head of the Minutes of the Association? I understand these rules refer to the Minutes of the meeting of the Association—discussions here in the convention. Should a member be allowed

to add to the discussions in the convention? I think that should come in as written discussion and not as a matter of addition to the speakers' remarks.

The President:—The custom has been heretofore to insert additions made to all the discussions with a prefix "by letter." I think that should be carried out and will fill the requirements. Is there any further discussion of Rule No. 8? If not, all in favor of the rule say aye. (The rule was adopted.)

The Secretary read Rule No. 9.

The President:—Is there any discussion of Rule No. 9? If not, all in favor will say aye. (The rule was adopted.)

The Secretary read Rule No. 10.

The President:—Is there any discussion of Rule No. 10? If not, all in favor of the adoption of the rule will say aye. (The rule was adopted.)

The Secretary read Rule No. 11.

The President:—Is there any discussion on Rule No. 11? If not, all in favor of the adoption of the rule will say aye. (The rule was adopted.)

The President:—The rules having been adopted by sections, it will not be necessary to adopt them as a whole.

Mr. A. S. Baldwin (Illinois Central):—I would like to call attention to an apparent inconsistency in Rule No. 7, which escaped my notice when it was read, as relating to Rule No. 11. Rule No. 7 states: "Reports will be published in the Proceedings in their original form, as presented by the committee; but the Secretary will prepare for convenience of reference a summary of the alterations recommended by the Association and insert the same immediately after the signature of the committee and preceding the discussion." The Association does not recommend these alterations. They are before the Association, and the Association adopts them either one way or the other. Now, there is another point about that rule. It says: "And insert the same immediately after the signature of the committee." That puts the Proceedings in an unfinished condition. I think it would be better if the changes adopted by the Association were referred back to the committee and the committee were required to incorporate in their report the changes adopted by the Association and then publish a complete report. It is not good to read over a committee report and then have to refer back to see whether or not what you are reading has been changed. That can be avoided by taking the changes that are adopted by the Association and incorporating them in the report before they are published.

The President:—I will state in behalf of the Board of Direction that it was thought it would be proper to change the word "recommended" to read "adopted." The word "recommended" was used upon the theory that the convention had no right to alter the report of a committee, and should not compel it to do so on such short notice, and therefore the amendments proposed here and adopted were simply recommendations to the committee; but, on further consideration, I find that the practice in other associations is to consider that amendments adopted by the convention

are conclusive, and must be accepted by the committee. I think, therefore, it would be well to change the word "recommended" to "adopted;" but as to the other plan suggested by Mr. Baldwin, it would involve expense in publication. It is necessary that the members should have the report as originally submitted, in order that they may know why the discussion took place, and it is necessary that at the same time we shall have the report as finally adopted; but in order that members may see what changes took place at the convention a summary of these changes is proposed at the bottom of the report, and it will stand in that shape in the Proceedings until the report is reprinted.

Mr. Baldwin:—In the printed Proceedings they will be corrected. The history of those changes will be in Bulletin form, until they are finally published in the Proceedings. Is not that sufficient record of the changes? When reports are published and adopted as Proceedings they should be reports of the Association as a whole.

The President:—Well, that would be a matter for the convention to decide. I would like to hear further discussion on that subject.

Mr. H. G. Kelley (Minneapolis & St. Louis):—I thought the situation was quite plainly stated by the President in his first reply to Mr. Baldwin. In the published Proceedings, with which we are all familiar, several pages are devoted to discussions. If the published Proceedings show the committee's report complete as amended, the discussions would have no sense to them after the meeting. If you leave the discussions out it would be of but little value. We must know of necessity what feature we were discussing. Therefore it seems to me that it is a necessity that a committee report be published first precisely as it was presented to the convention, and then, as an addendum to the report, the various conclusions arrived at by the Association and adopted by the Association are shown. Now, with such an arrangement before you, the discussion by the convention at large becomes clear, and the reader not familiar with it is immediately advised of the entire action of the Association.

The President:—The chair has permitted this discussion to proceed, although it is out of order. He does not wish to put a cloture rule on the convention, but in order to take it up properly, you will have to make a motion to reconsider.

Mr. Baldwin:—I will withdraw my suggestion.

The President:—We will take up the report of the Committee on Buildings, Mr. Parkhurst, of the Illinois Central, chairman. We would like to have Mr. Parkhurst make any remarks he may wish to make in presenting the report. (See report, pp. 33-44; discussion, pp. 45-64.)

The President:—We will next take up the report of the Committee on Ties, Mr. E. B. Cushing, chairman. I regret to state that the chairman of the Committee has written a letter saying that he is not able to be present. Are there no other members of the Tie Committee present? We are fortunate in having one, and will proceed with him. We regret the absence of the chairman, but Mr. Curtis will present the report with such remarks as he may desire to make. (See report, pp. 65-97; discussion, pp. 97-132.)

We will next take up the report of the Committee on Yards and Terminals, Mr. W. G. Besler, Vice-President and General Manager of the Central Railroad of New Jersey, chairman. (See report, pp. 133-212; discussion, pp. 212-226.)

(First Vice-President Kelley in the chair.)

Vice-President Kelley:—The Committee on Records, Reports and Accounts, Mr. Edwin F. Wendt, Assistant Engineer, Pittsburg & Lake Erie, chairman, is ready to report. (See report, pp. 227-347; discussion, pp. 348-378.)

WEDNESDAY, MARCH 16, 1904.

MORNING SESSION.

The President:—The first business this morning is the consideration of the report of the Committee on Signs, Fences, Crossings and Cattle-Guards, Mr. A. S. Baldwin, of the Illinois Central, chairman. We would like to have a statement from the chairman of the Committee as to his report. (See report, pp. 379-440; discussion, pp. 441-462.)

Mr. J. W. Schaub (Consulting Engineer):—I move that the rules be suspended for a time to consider a supplementary report by the Committee on Iron and Steel Structures.

The President:—Will the gentleman state the object?

Mr. Schaub:—I understand the Committee on Iron and Steel Structures has submitted a table on standard upsets which they are very anxious to have passed upon by this convention. I presume a motion is in order to either adopt or reject this report.

The President:—I hardly think the convention would be in position to decide whether it is desirable to suspend the rules unless your statement should give some idea of the contents of the report.

Mr. Schaub:—As I understand it, the different shops throughout the country use their own standards for upsets, and the idea of this table is to suggest some standard. Some members are under the impression that the standard in use is the table given by the bridge companies. Such is not the case. The different shops use their own standards, and no two are alike, and therefore the Committee is very anxious to have the table of upsets adopted. I am not prepared to defend it or to recommend it, and was in hopes some member of the Committee would tell us something more about it.

The President:—A two-thirds vote is required to suspend the rules.

(The motion to suspend the rules was put to a vote and lost.)

The President:—The Track Committee is not ready to report. We will take up the report of the Rail Committee next, Bulletin No. 47. The chairman will please make a preliminary statement in introducing his report. (See report, pp. 463-470; discussion, pp. 471-480.)

AFTERNOON SESSION.

The President:—The first business we will take up this afternoon will be the report of the Committee on Ballasting. (See report, pp. 481-495; discussion, pp. 496-514.)

The President:—The next matter on the program is the report of the Track Committee. The chairman will please make such remarks as he desires in presenting the report. (See report, pp. 515-534; discussion, pp. 536-574.)

THURSDAY, MARCH 17, 1904.

MORNING SESSION.

President McDonald called the convention to order at 9:30 a. m., and the discussion of the report of the Committee on Track was resumed.

President McDonald:—We have now finished the consideration of this matter. I understand that Mr. Webster desires to discuss a point of order in connection with the matter which was up for consideration yesterday.

Mr. Wm. R. Webster (Consulting Engineer):—I merely want to say, if it is in order, that in the discussion of the general rules on Tuesday it was decided that when papers were read by title they were open for discussion.

The President:—The point of order is well taken. We will consider first the point which Mr. Webster first made. This matter of iron and steel structures was not in the form of a committee report. It was merely submitted by the Committee to enable us to have it published in our Proceedings and to be used as a basis for a report which was to follow. It is desired by the Committee to alter three of these paragraphs in such a way that they can be used in the specifications. Am I not correct?

Mr. Webster:—No, sir; the specifications were adopted a year ago. This is in reference to specifications which were adopted and which are in use to-day, but during the year the Committee has seen the trouble that these clauses are likely to give. The mills are willing to meet the changes which I desire to refer to.

The President:—The gentleman will state the changes.

Mr. Webster:—I think Mr. Schneider, a member of the Committee, is here, and if he will give the conclusions of the Committee it will save time to have him do it. I merely want the Committee to show the good work they are doing.

(See discussion on changes proposed by Mr. C. C. Schneider of paragraphs 2, 9, 13, 16 and 33 of the adopted specifications for Material and Workmanship for Steel Structures, pp. 581-584.)

AFTERNOON SESSION.

The President:—The next business in order is the report of the Committee on Water Service. An opportunity will be given the Committee to make any further remarks regarding the introduction of its report which it desires. (See report, pp. 585-595; discussion, pp. 596-600.)

The President:—The next item on our program is the report of the Committee on Masonry. I wish to state for the information of the convention that the specifications for Portland cement are now being considered by a committee of the American Association for Testing Materials, and they have asked for representatives of the American Society of Civil Engineers, the American Association of Cement Manufacturers and of this Association to meet that committee. In compliance with that request, the Board of Direction has appointed Mr. H. G. Kelley, Prof. G. F. Swain and Mr. C. W. Boynton to represent this Association. Mr. Boynton and Professor Swain are already on the joint committee as representing other associations. Our instructions to our delegation are that they participate in the proceedings and report their action back to this convention for approval. The discussion and adoption of the proposed specifications, it seems to me, would therefore be unnecessary in view of that action. I think the Committee agrees with the chair on that point. We will hear from the chairman of the Committee. (See report, pp. 601-635; discussion, pp. 636-666.)

The President:—There are two committee reports that have not been considered by this convention, and it is desired that these reports be read by title, in order that, under our rules, they can be placed in the Proceedings and the committees can take up something else. The reports are those of the committees on Roadway and Wooden Bridges and Trestles.

Mr. C. S. Churchill (Norfolk & Western):—I move that the two reports be read by title.

Motion carried. (See report on Roadway, pp. 667-718; discussion, pp. 719-728; Report on Wooden Bridges and Trestles, pp. 729-735; discussion, pp. 737-747.)

Mr. E. C. Brown:—My attention has just been called to a matter referred to in the report of the Committee on Masonry, in which the Committee asks for authority to co-operate with the American Society of Civil Engineers in the matter of concrete steel or reinforced concrete, and ask for instructions. We would like to know how that will be handled; whether the Board will take cognizance of that and give us the necessary instructions to take the matter in hand and appoint a sub-committee, or will another committee be appointed for that purpose?

The President:—The chair has already stated the way that matter now stands, and if the convention confirms the action taken by the Board, the Committee's request will be answered in the negative.

Mr. Brown:—This is not the same matter.

The President:—This is on reinforced concrete. It occurs in connection with what we have to say on the theory and design of reinforced concrete.

(On motion, the Committee on Masonry was given authority to co-operate with the American Society of Civil Engineers.)

The President:—The next item is new business.

The Secretary read the following communication from the authorities of Purdue University, offering the committees of the Association the use of the testing facilities at the laboratory:

MR. HUNTER MCDONALD, President, American Railway Engineering and Maintenance of Way Association, Nashville, Tenn.

MY DEAR SIR:—

Through the courtesy of Professor W. F. M. Goss, Dean of the Engineering Schools, and Director of the Engineering Laboratory of Purdue University, I am permitted to extend to the American Railway Engineering and Maintenance of Way Association an invitation to make use of the official Master Car Builders' drop-testing machine, recently established in the Purdue laboratories. The invitation, as you will see in the attached letter from Dean Goss, includes the use by authorized committees of any equipment contained in the laboratory, subject only to necessary regulations of a business nature.

I may say that this invitation was suggested by a conversation which I had with the chairman of the Rail Committee at the last annual convention, when it appeared that his committee might possibly desire to undertake a series of tests, with a view to standardize the drop-test for steel rails.

Should the authorities or any of the committees of the Maintenance of Way Association decide to avail themselves of this invitation, the matter may be taken up directly with Dean Goss, Director of the Engineering Laboratory. Professor W. K. Hatt is directly in charge of the Materials Testing Laboratory. Very respectfully,

W. D. PENCE,

Professor of Civil Engineering (Member A. R. E. & M. of W. Assn.).

PROFESSOR W. D. PENCE, School of Civil Engineering, Purdue University.

DEAR SIR:—

Referring to our recent conversation, with reference to the availability of the Master Car Builders' drop-testing machine for purposes of the Maintenance of Way Association in testing rails, I beg to submit the following: It has always been our custom to co-operate with committees of representative societies in advancing problems of research to the full extent of our ability, and, conforming to this policy, we shall be glad to extend to the Maintenance of Way Association the full use of any apparatus in our laboratory, including the Master Car Builders' drop-testing machine.

With reference to the drop-testing machine, I would say that it has been designed for rail testing. While the drop only weighs 1,650 pounds, to meet the requirements for axle and coupler testing, provision is made for adding supplemental pieces which bring its weight up to 2,000 pounds, which is necessary to meet the specifications for rails. It is my understanding, therefore, that we are entirely prepared to undertake tests of rails.

If the Maintenance of Way Association should see fit to undertake tests through any of its duly authorized committees, the University will agree to make available the facilities of its laboratory, and to supply power to operate the same. The University will agree, also, to have the work supervised by those usually in charge of the apparatus involved, all without cost to the Association. If, however, the work involves costs not covered by the foregoing statement, such, for example, as freight, switching or drayage charges, or cost for extra labor in handling materials, we should expect to bill against the Association to reimburse us for our actual

expenditures. The drop testing machine is of such a character and the materials to be tested are of such weight, that I assume it would be necessary to have an extra man or two during the time the tests are in progress. Very truly yours,

W. F. M. Goss.

Mr. E. C. Brown:—I move that the offer of the Board of Trustees of Purdue University be accepted, and that we return our thanks for their offer.

(Motion carried.)

The President:—The chair stated this morning that the Board of Direction had appointed Mr. H. G. Kelley, Professor Swain and Mr. C. W. Boynton to represent this Association in connection with the work regarding cement which has been taken by the American Society for Testing Materials, and in which the American Society of Civil Engineers and the Association of Portland Cement Manufacturers will co-operate.

(On motion of Mr. John Dean, the action of the Board of Direction was approved.)

The Secretary announced the result of the vote on the proposed amendments to the Constitution, as follows:

Total number of votes	177
For all the amendments proposed	167
Against the amendments	4
For all amendments, except Section 2, Article V	1
For all amendments, except Sections 2 and 3, Article V	1
For all amendments, except Section 1, Article VIII	1
Members voting blank	2
Ballots not signed	1
	177

The President:—The necessity of copyrighting the publications of the Association, especially the Bulletins, has been considered. The Board is of the opinion that it should be done, and that the publication of the Bulletins should be withheld from the public press until they are presented to the Association.

Mr. Walter G. Berg (Lehigh Valley):—I think the sphere of usefulness of the Association is aided by wide publication of all our Proceedings, and reproduction of any matter published by us should be free and unhampered; at the same time, I fully agree with the idea that the advance issues of matter should not be published until received before the convention. Advance publications are constantly issued by courtesy and are put out on the condition that they will not be republished until presented at the convention. Sometimes a memorandum is put upon them, "Not to be republished until ...," giving a specified date. I think any reputable publication will regard that memorandum, and that ought to be sufficient, so that it will not require copyrighting.

The President:—The Board is obliged to Mr. Berg for his expression, as he has had a good deal of experience along these lines.

In connection with the Bulletin, a tentative vote was taken as to

whether it should be continued. The result has been printed in a leaflet, which has been distributed. It is not intended for publication, but simply for the information of the members present. The Secretary will read the result of the ballot.

The Secretary:—The following is the result of the vote on the question of continuing the publication of the monthly Bulletins:

For continuing the Bulletin	183
Against	1

Mr. W. M. Camp (Railway and Engineering Review):—I desire to offer the following resolution:

"Whereas, The American Railway Engineering and Maintenance of Way Association recognizes the necessity and high value of the work now being conducted under the auspices of the Bureau of Forestry, United States Department of Agriculture, in determining the strength of various commercial timbers of the United States, and in investigation of the best methods for handling and preserving timbers, to the end that safe, economical and durable structures may be built, and sources of supply otherwise neglected may be made available; and

"Whereas, The Association further recognizes the value of this work in promoting the economical use of existing supplies, and in making possible the conservative administration of forest tracts in the general interests of forestry.

"Be it Resolved, That the Association hereby records its appreciation of the work thus far accomplished, and urges the Honorable Secretary of Agriculture to request Congress to make such appropriation as may be necessary to carry on this work in the most effective and satisfactory manner.

"The Secretary of the Association is directed to send a copy of these resolutions to the Honorable Secretary of Agriculture and to the Forester, Bureau of Forestry."

(On motion, the resolution was adopted.)

The Secretary read a communication from Professor Alfred E. Phillips, Department of Civil Engineering, Armour Institute of Technology, thanking the Association for the courtesy extended in inviting the junior and senior classes of the Institute to attend the meeting.

The President:—The Secretary will announce the result of the ballot for officers.

The Secretary:—The following is the report of the tellers appointed to canvass the votes for officers:

Total vote cast	225
For President, Hunter McDonald	225
For Vice-President, James Dun	225
For Treasurer, W. S. Dawley	225
For Secretary, L. C. Fritch	225
For Director, Walter G. Berg	225
" " W. L. Breckinridge	222

The President, being called upon, made the following remarks:

President McDonald:—Gentlemen, I wish to say that I am very much

complimented by the vote that has been given me for President. I have done all I could to serve you in the past and will do all I can in the future.

(On motion, the convention adjourned *sine die.*)

The sixth annual convention will be held in Chicago, Ill., beginning Tuesday, March 21st 1905.

E. H. FRITCH,
Secretary *pro tem.*

COMMITTEE

REPORTS AND DISCUSSIONS

REPORT OF COMMITTEE NO. VI.—ON BUILDINGS.

To the Members of the American Railway Engineering and Maintenance of Way Association:

Your Committee on Buildings begs to submit the following report:

(1) DEFINITIONS.

The Board of Direction has instructed that the Committee on Buildings consider this year, among other things, the subject of proper definitions of technical terms used in connection with the work of the Buildings Committee. The terms used in the original program outlining the work proposed to be done by the Association under the heading of "Buildings" are, in general, clearly understood by all members of the Society, but it is proposed that exact definitions should be given for these terms, so that, in the discussion of the subjects connected with the work of the Committee, there will be no misunderstanding as to the scope, and so that accurate language may be used. In the following only technical definitions are given, with occasional reference to ordinary or technical use of the same, or similar words, for the sake of illustration and to distinguish the technical meaning more fully.

BUILDING.—A built thing, or things built. A fabric built or constructed; a structure; an edifice; as commonly understood, a house for residence, business, or public use, or for shelter of animals, or storage of goods. In law, anything erected by art, and fixed upon or in the soil, composed of different pieces connected together and designed for permanent use in the position in which it is fixed. In law, a fence or wall may be a building; a pole may not.

Railroad Buildings are those constructed for use in connection with the maintenance and operation of a railroad. The primary idea is that of shelter, either to passengers, goods, or workmen. As compared with the above, the synonymous terms are as follows:

DEPOT.—A place of deposit, a depository, a warehouse or storehouse for receiving goods for storage, sale, or transfer.

RAILROAD STATION.—A place for the accommodation and shelter of passengers and the receipt and transfer of freight by railway.

EDIFICE.—A building, a structure, an architectural fabric. This term is applied chiefly to large or fine buildings, either public or private.

HEADHOUSE.—This is a term used to define a particular kind of station and involves the idea of a construction at the terminal point of a railroad where the tracks stop and across the ends of which the building is constructed.

Your Committee recommends the use of "Station" as more definite and exact, rather than either of the above synonyms.

FREIGHT.—Something borne, load, cargo, lading; originally carried by water but now, in the United States and Canada, anything carried either by water or by land, as the lading of a ship, canal boat, or a railroad car, or a wagon. The word freight applies both to the thing carried and also to the amount paid for its carriage.

PASSENGER.—(1) One who passes or is on his way; a passerby; a wayfarer; a traveler.

(2) (Engineering.) One who travels in a public conveyance; one who travels in such a conveyance by virtue of a contract, express or implied, with the carrier, as payment of a fare or something accepted as an equivalent therefor.

SHOP.—(1) A boot or stall where wares were usually both made and displayed for sale.

(2) A building or a room or suite of rooms appropriated to the selling of wares at retail.

(3) A room or a building in which the making, preparing and repairing of any article are carried on, or in which any industry is pursued, as in a machine shop; hence figuratively

(4) The place where anything is made or repaired.

It is to be noted that the word shop, in the sense used in railroad maintenance, is remotely derived from the original meaning of the word, it being the place where machinery, etc., is made or repaired.

MACHINE.—(1) An engine; an instrument of force.

(2) In mechanics, in general, any instrument for the conversion of motion. The above is the more general meaning of the word machine. Its origin is from the same root as the word "make" and implies the idea of something made or constructed to be used in performing other work.

MACHINE SHOP.—A workshop in which machines or parts of machines are made and repaired.

ROUNDHOUSE.—On American railroads, a building usually round, and built of brick, having stalls for the storage of locomotives, with tracks leading from them to a central turntable (in Great Britain called Engine-House and Engine-Shed).

It is to be noted that the essential idea of a roundhouse in American railroad language is that it is a building for the storage (and repair) of locomotives, hence the name is legitimately applied to any building, whether square or round, which is used for this purpose.

TURNTABLE.—A revolving girder, of wood or iron, usually placed in a circular pit, and used either for reversing engines or cars, or to receive locomotives from one track or set of tracks and to deliver them to either of the radiating tracks of a roundhouse.

TRANSFER TABLE.—A rolling or sliding girder or table on which cars, engines, etc., may be run to be carried across from one track or set of parallel tracks to another track or set of parallel tracks; this girder moving usually at right angles to both sets of tracks and arranged

to permit the transfers above described. Such a table is usually constructed for use in connection with square buildings having parallel tracks, for the construction, storage or repair of engines or cars or other apparatus designed to travel on railroad tracks.

CHUTE.—A fall; an inclined trough or tube along which things can slide from a higher to a lower level; a shoot. A coal-chute, therefore, is a piece of apparatus for the delivery of coal primarily from a higher to a lower level. The term, however, has now (in America) come to mean the whole set of mechanical appliances by which coal is received from cars and handled—or stored and handled—until it is delivered to the tenders of a locomotive.

PLANT.—In engineering, the fixtures, machinery, tools, apparatus, appliances, etc., necessary to carry on any trade or mechanical operation or process.

CINDER PIT.—A place for depositing cinders, ashes, etc., from locomotives, including, generally, the necessary apparatus for removing them and loading them on cars.

WATER CRANE.—An apparatus for supplying water from an elevated tank, as to the tender of a locomotive; also, a water column.

PLATFORM.—(Also originally Plotform.) In engineering, a raised frame or structure with a level surface, as a raised walk along the track of a railroad station for loading or unloading passengers and freight.

STORE.—(1) That which is provided or furnished for use as needed; a stock, accumulated, as for future use; a supply, a hoard; specifically, in the plural, articles, particularly of food, accumulated for a specific object; supplies, as of food, ammunition, arms, or clothing; as military or naval stores; the winter supply of a family.

(2) A place where provisions, etc., are stored, hence

STOREHOUSE.—A house in which things are stored; a building for the storing of grain, food stuffs or goods of any kind; a warehouse, a store.

FREIGHT HOUSE.—(Engineering.) A building for the receipt, storage, or transfer of freight, goods, commodities, provisions, etc. It may be used for either or all of these purposes and, if the station is a small one, is built as a "COMBINATION STATION" of this kind.

AT LARGE STATIONS AND TERMINALS.

IN-FREIGHT HOUSES are used for the receipt, storage, handling and delivery of freight brought in by cars and generally delivered to teams.

OUT-FREIGHT HOUSES are used for the receipt of freight from various local sources, merchants, etc., and to handle it into cars to be shipped out to the purchasers who may be located on various railroad lines.

A TRANSFER HOUSE or PLATFORM may also be provided for the transfer of freight from one line or set of cars to another, or for the accumulation of smaller quantities from several cars into "car-load lots" for subsequent disposition.

(2) PASSENGER STATIONS.

Circulars were sent by the Secretary of the Association at the request of the Committee on Buildings to various railroad companies in the United States and adjacent countries, requesting them to send plans and data showing at least a ground plan, front elevation and transverse section of a Passenger Station constructed for a town or city having a population of from 10,000 to 15,000 people. It was further specified that it should be a station on the line and not a "terminal" station. In all there have been received sixty-five plans from thirty-one different railroad companies; and for convenience of reference the information as to the distribution of space in these stations has been tabulated in the following table.

A Passenger Station to accomplish its purposes should provide the following essential conveniences:

(1) Waiting rooms for the passengers who are either taking or leaving trains, or for the people who accompany such passengers. These waiting rooms should, of course, be provided with convenient toilet rooms, dressing rooms, etc., as occasion demands.

(2) Baggage rooms are essential for the receipt, handling and delivery of the passengers' baggage.

(3) Ticket offices will be required at which the passengers purchase tickets and obtain information as to their routes, etc.

A tabular statement of the conveniences furnished has been made up to embody the information given in the plans as to the space apportioned to these several uses, including, in addition, columns showing the space assigned for halls and vestibules, for express service and for freight rooms.

As to waiting rooms, it will be noted that no fixed plan has been followed. Separate waiting rooms are frequently provided for the different sexes. At times a general waiting room is intended to serve for both sexes, accompanied by either a separate men's or a separate women's waiting room. In some of the larger stations, only a general waiting room is provided for all. Therefore to make a comparison, and to arrive at the average space which should be assigned for the purpose of waiting rooms, a column has been placed in the table, showing the total waiting room space assigned.

Again, as to toilet rooms, no uniform plan is followed. Frequently a women's dressing room or retiring room is provided; and it is also common to find in the larger stations a separate smoking room for men; these in addition to the usual toilet conveniences. For the purposes of comparison, the areas have been grouped into two columns, one for men and one for women, and a column is also added containing the totals.

The allowance of space for baggage room varies very widely in different stations; and, as will be noted, where a station serves the combined purpose of freight and passenger station, no baggage room is provided, but the baggage is handled in the freight room.

Only a small portion of the plans received showed provisions for handling express matter.

The space assigned for ticket offices varies very widely, but as may be supposed is never omitted.

A great deal of ingenuity has been manifested in the construction of stations in which no room has been wasted for halls and vestibules. Less than one-half of the plans received provided halls, passageways, vestibules, etc., for the protection of entrances.

Summing up the totals of the space assigned for different purposes and dividing by the number of stations as shown at the foot of the tabular statement, gives an average area, which we may legitimately assume as an "average" requirement for a Passenger Station of this character.

The averages are as follows:

Space assigned for waiting rooms	1,160 sq. ft.
Space assigned for toilet rooms	186 sq. ft.
Space assigned for baggage rooms	433 sq. ft.
Space assigned for ticket offices	218 sq. ft.
Making a total of	1,997 sq. ft.

Our typical station would not provide for handling express matter, nor would it have halls or vestibules at the entrances.

Assuming a width of twenty-four (24) feet between main walls, the length of station required to make up the above area would be about eighty-four (84) feet exclusive of walls and partitions. The very general arrangement has been followed of placing the ticket office in the center on the side of the station next to the track, placing the toilet rooms opposite these, leaving a passage between, which would connect the two principal waiting rooms, one for men and one for women. If we assume that the desirable plan would be to provide for a general waiting room at one end of the building for both men and women, a symmetrical building might be constructed by dividing the total space so as to place the women's waiting room and baggage room in one main wing, while the general waiting room should be in the other.

The Building Committee is not prepared to make any recommendations as to a "standard" or "typical" plan for Passenger Stations, based on the above. The conditions under which such structures have to be built are so varied that no general plan would probably be acceptable to any number of railroads. The comparison with what has been done may, however, be instructive, and the above matter is presented with that idea in mind, rather than with any hope of arriving at a standard for such a Passenger Station.

(3) CONTRACTS AND SPECIFICATIONS.

GENERAL FORM OF CONTRACT.

At the request of the Committee on Buildings, circular letters were sent out to 200 railroads, requesting information as to the forms of contracts and specifications used by them in connection with building construction. Forty-five replies were received. Out of this number, thirteen only have a printed form of general contract for building construction, the remainder

DISTRIBUTION OF SPACE ON PLANS RECEIVED FROM SUNDRY RAILROADS, SHOWING STATIONS DESIGNED FOR CITIES OF 10,000 TO 15,000 INHABITANTS.

Railroad.	Station Name.	No. of Plan.	Waiting Rooms.				Toilet Rooms.			Freight Rooms.	Baggage.	Express.	Ticket Offices.	Halls and Vestibules.	Miscellaneous.
			Men's	Women's	General.	Totals.	Men's	Women's	Totals.						
A., T. & S. Fe	Hutchinson	1	720	720	.....	1,440	107	107	214	.....	786	700	328	162	
B. & O.	Class A	48	203	.....	.....	203	.....	.....	.....	248	.....	.....	148	.....	
	" B	49	298	.....	.....	298	.....	.....	.....	366	.....	.....	185	.....	
	" C	50	371	.....	.....	371	.....	.....	.....	561	.....	.....	203	.....	
B. & L. E.	Erie	2	.....	518	518	1,036	54	60	114	.....	274	.....	156	72	
	Greenville	3	.....	150	832	982	56	47	103	.....	322	.....	191	.....	
B. & M.	Lakeport	4	.....	.....	492	492	61	79	140	.....	228	140	117	72	
	Manchester	5	.....	65	926	991	110	45	155	.....	613	.....	130	60	
	Northampt'n	6	.....	172	2,370	2,542	234	115	349	.....	1,290	484	290	225	
B. R. & P.	Bradford	51	.....	667	775	1,442	40	40	80	.....	539	128	70	56	
	Dubois	52	.....	727	1,140	1,867	90	38	128	.....	532	542	130	84	
	Punxsutan'y	53	.....	645	.....	645	38	38	76	.....	443	283	130	141	
B. C. R. & N.	Faribault	7	.....	.....	1,748	1,748	144	160	304	.....	666	.....	356	.....	
C. P. Ry.	No. 1 Station	56	.....	352	602	954	86	52	138	.....	225	.....	125	72	
C. of Ga.	Alexander City	8	436	516	.....	952	.....	.....	.....	.....	121	.....	369	.....	
Cent'l Ont.	Picton	9	.....	312	400	712	.....	38	38	.....	349	.....	319	180	
" Verm't.	Windsor	54	.....	576	576	1,152	50	50	100	.....	336	336	147	133	
C. G. W.	Faribault	10	507	330	.....	837	41	41	82	.....	280	.....	160	53	
	Marshallto'n	11	473	344	.....	817	48	35	83	.....	452	253	162	178	
	St. Joseph	12	.....	160	840	1,000	62	38	100	.....	450	590	208	.....	Kitchen and Dining Room.
C., M. & St. P.	Chippewa	13	361	333	944	1,638	58	61	119	.....	407	.....	150	.....	
	Washington	14	736	736	.....	1,472	74	74	148	.....	506	.....	164	93	
	Spencer	15	.....	420	778	1,198	54	60	114	.....	437	276	211	.....	
C. R. & M.	Stand. No. 2	16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	220	.....	
	" " 1	17	.....	.....	336	336	132	.....	132	.....	.....	.....	272	.....	
	Muncie	18	176	311	807	1,294	71	53	124	.....	371	.....	130	.....	
Erie	Rutherford	19	.....	196	760	956	99	89	188	.....	250	.....	224	168	
	Lackawaxen	20	.....	123	435	558	63	55	118	.....	.....	.....	219	.....	
Ft. W. & D. C.	Wichita Falls	21	.....	351	930	1,281	33	33	66	.....	360	.....	150	165	
Frisco	Chickaska	55	196	93	550	839	.....	.....	.....	.....	352	.....	352	.....	
G. C. & S. F.	Gainesville	63	* 625	* 625	.....	1,250	* 112	* 112	224	.....	500	550	170	.....	Lunch and Kitchen.
Ill. Cent.	Denison	22	.....	630	637	1,267	100	100	200	.....	357	357	200	88	
L. S. & M. S.	Conneaut	23	681	1,147	.....	1,828	56	74	130	.....	466	.....	205	81	
	Bellevue	24	360	624	.....	984	30	51	81	.....	252	.....	136	75	
	Sturgis	25	360	640	.....	1,000	31	54	85	.....	250	.....	157	65	

Lehigh Val.. .	Manch. Ch'k	26	323	.....	1,600	1,923	200	168	368	... ..	312	448	130	.....	Emigrant Room.
	Spencer Junc	27	.....	.....	705	705	.....	.....	.....	1,048	.....	80	354	.....	
	Hector.....	28	.....	.....	515	515	.....	.....	.....	662	.....	.....	222	60	
L. & N.	Columbia....	29	* 504	* 700	1,080	2,284	275	255	530	.....	560	.....	144	330	
	Henderson ..	30	* 596	* 644	1,110	2,350	* 297	* 280	577	.....	840	504	142	263	
Mex'n Cent....	Irendain.....	31	.....	.....	288	288	.....	.....	.....	2,880	288	.....	528	.....	
Mich. Cent. ..	Chelsea.....	59	850	600	.....	1,450	72	84	156	.....	500	.....	240	.....	
	Three Oaks.	60	.....	342	248	590	.....	.....	.....	.....	262	.....	224	.....	
	Charlotte.. ..	61	.....	357	483	840	110	75	185	.....	285	190	255	.....	
	Niles	62	.....	.....	1,160	1,160	.....	.....	156	.....	484	.....	182	.....	Dining Room. etc.
M. K. & T	Frame Stat'n	57	432	272	.....	704	.....	.....	.....	1,416	345	.....	421	.....	
	" "	58	480	284	.....	764	.....	.....	.....	1,584	414	.....	421	.....	
N.Y. C.& H. R.	Chelsea.....	32	.....	.....	334	334	29	29	58	416	.....	.....	170	.....	
	Fort Plain...	33	.....	.....	1,247	1,247	94	77	171	.....	388	.....	192	83	
	St.Johnsville	34	.....	.....	834	834	81	59	140	.....	210	.....	180	30	
	Geneva.....	35	228	144	2,142	2,514	120	120	240	.....	672	672	240	930	
	Herkimer....	36	240	192	1,868	2,300	105	105	210	.....	806	.....	232	.....	
	Amsterdam..	37	160	160	1,939	2,259	95	95	190	.....	812	.....	218	212	
N.Y., N.H.& H.	Danbury	38	.....	.....	2,856	2,856	250	250	500	.....	625	890	576	1,624	
	Lenox.	39	.....	.....	1,447	1,447	180	180	360	.....	473	264	145	.....	
N. C. & St. L..	Paris	64	.....	* 556	696	1,252	220	115	335	.....	324	.....	150	.....	
	Marietta.....	65	.....	* 516	516	1.032	111	77	188	.....	336	.....	205	.....	
P. & R.....	Quakertown...	40	143	.....	886	1,029	150	124	274	.....	264	.....	158	50	
P. & L. E.....	Beaver, Pa ..	41	.....	351	870	1,221	120	154	274	.....	192	.....	183	99	
	Monessen....	42	.....	.....	1,200	1,200	52	52	104	.....	252	.....	155	.....	
	Beaver Falls	43	.....	.....	726	726	91	91	182	.....	263	.....	146	.....	
So. Pacific....	Redwood, Cal..	44	.....	220	682	902	38	51	89	.....	451	.....	513	.....	
So. Indiana ...	Bedford.....	45	625	500	.....	1.125	113	113	226	.....	531	.....	41	39	
	Seymour	46	466	466	.....	932	113	113	226	.....	512	.....	82	.....	Lunch Room. etc.
	Linton	47	519	519	.....	1.038	.....	.....	.....	1.348	.....	.....	360	.....	
			12.069	19,306	42,828	74,203	5,050	4,466	9,672		23.815	7.687	14,093	5,943	
Total No. of each averaged.....			28	45	45	64	50	50	52	.....	55	19	65	31	
Average Area of each class.....			430	430	952	1,160	101	90	186	.....	433	405	218	192	
Minimum Area.			143	65	248	203	29	29	38	.....	121	80	41	30	
Maximum "			850	1,147	2,856	2,856	297	280	577	.....	1,290	890	576	1,624	

* Includes Provisions for Colored Passengers

using special forms for each individual piece of work. Eight of these railroads only have general forms of printed specifications, the remainder using special forms adapted particularly to the work proposed. But few, therefore, have any printed forms of contracts and it is doubtful whether a printed form can be prepared which would be satisfactory as a general form of contract for building construction. Each special case usually requires a peculiar modificattion. There is a further probability that in each different State in the Union there are special laws in regard to contracts to be considered which may make it necessary to modify materially the form of contract to be used.

The essential parts of a contract are four, namely:

(1) Two competent parties.
(2) Lawful consideration.
(3) Lawful subject-matter.
(4) Mutual assent and understanding.

These essential parts are, of course, to be expanded, but the line should be closely drawn, separating the contract proper from the specifications. Your Committee has considered it essential that a form of contract to be recommended should contain only such matters as belong properly to the contract, and that the specifications should be entirely distinct. It frequently happens that what would otherwise be a good contract is marred by mixing with it matters that belong properly in the specifications.

Your Committee has not had time to discuss fully the details of a form of general contract, but they present the following as a general form which contains the essential elements of a contract, trusting that the members of the Association may discuss the same, either in writing or orally, and that out of it may possibly be built up a general form which may be found acceptable.

PROPOSED FORM OF BUILDING CONTRACT—AM. RY. ENG. & M. OF W. ASS'N.

THIS AGREEMENT, made the.....day of.....A. D. 190.. by and between.... .....,..... ..... party of the first part (hereinafter designated the Contractor), and..... ..... party of the second part (hereinafter designated the Company).

WITNESSETH, that the Contractor, in consideration of the fulfillment of the agreements herein made by the Company, agrees with the said Company, as follows:

ARTICLE I.—The Contractor under the direction and to the satisfaction of the Chief Engineer (hereinafter designated the Engineer), acting for the purposes of this contract for the said Company shall and will provide all the materials and perform all the work mentioned in the specifications and shown on the drawings for the erection and completion of ..... which drawings and specifications are identified by the signatures of the parties hereto.

It is agreed that all work exhibited, or provided to be done in the plans or drawings, and not mentioned in the specifications, or vice-versa, shall be executed and performed without extra charge as if the same were fully mentioned and described in each thereof respectively.

ARTICLE II.—The Engineer shall furnish to the Contractor such further drawings or explanations as may be necessary to detail and illustrate the work to be done, and the Contractor shall conform to the same as part of this contract so far as they may be consistent with the original drawings and specifications.

It is mutually understood and agreed that all drawings and specifications are and remain the property of the Company and are to be returned on completion of building.

ARTICLE III.—No alterations shall be made in the work shown or described by the drawings and specifications except upon a written order of the Engineer, and when so made, the value of the work added or omitted shall be computed by the Engineer, and the amount ascertained shall be added to or deducted from the contract price. In case of dissent, disagreement, or dispute, the decision of the Engineer shall be final and binding.

ARTICLE IV.—The Contractor shall provide sufficient, safe and proper facilities at all times for the inspection of the work by the Engineer or his authorized representatives. He shall, within twenty-four hours after receiving written notice from the Engineer to that effect, proceed to remove from the grounds or buildings all materials condemned by him, whether worked or unworked, and to take down all portions of the work which the Engineer shall, by like written notice, condemn as unsound and improper, or as in any way failing to conform to the drawings and specifications.

The Contractor agrees to keep a competent man on the works all the time during working hours to receive instructions from the Engineer.

ARTICLE V.—Should the Contractor at any time refuse or neglect to supply a sufficiency of properly skilled workmen, or of materials of the proper quality, or fail in any respect to prosecute the work with promptness and diligence, or fail in the performance of any of the agreements herein contained, such refusal, neglect or failure being certified by the Engineer, the Company shall be at liberty, after..... days' notice (written) to the Contractor, to provide any such labor or materials and to deduct the cost thereof from any money then due or thereafter to become due to the Contractor under this contract, and if the Engineer shall certify that such refusal, neglect or failure is sufficient ground for such action, the Company shall also be at liberty to terminate the employment of the Contractor for the said work and to enter upon the premises and take possession, for the purpose of completing the work comprehended under this contract, of all materials, tools and appliances thereon, and to employ any other person or persons to finish the work, and to provide the materials therefor; and in case of such discontinuance of the employment of the Contractor he shall not be entitled to receive any further payment under this contract until the said work shall be wholly finished, at which time, if the unpaid balance of the amount to be paid under this contract shall exceed the expense incurred by the Company finishing the work, such excess shall be paid by the Company to the Contractor but if such expense shall exceed such unpaid balance the Contractor shall pay the difference to the Company. The expense incurred by the Company as herein provided, either for furnishing materials, or for finishing the work, and any damage incurred through such default, shall be audited and certified by the Engineer, whose certificate thereof shall be conclusive.

ARTICLE VI.—The Contractor shall complete the several portions and the whole of the work comprehended in this agreement by and at the time or times hereinafter stated.....
.....
.....
.....
.....
.....
.....

ARTICLE VII.—Should the Contractor be obstructed or delayed in the prosecution or completion of his work by the act, neglect, delay or default of the Company, or of any other contractor employed by the Company upon the work, or by any damage which may happen by fire, lightning, earthquake or cyclone, or by the abandonment of the work by the employés through no default of the Contractor, then the time herein fixed for the completion of the work shall be extended for a period equivalent to the time lost by reason of any or all of the causes aforesaid; but no such allowance shall be made unless a claim therefor is presented in writing to the Engineer within twenty-four hours of the occurrence of such delay.

IT IS FURTHER AGREED, Should the said Contractor fail to finish the work at or before the time agreed upon as aforesaid, he shall pay or allow the said Company by way of liquidated damages, but not as penalty, the sum of ..... Dollars per diem for each day and every day thereafter the said work shall remain incomplete, which amount may be deducted from any moneys that may be due him on the proper completion of this contract.

The Contractor shall supply the Company with good and sufficient bond to the amount of ..... Dollars for the faithful carrying out and completing this contract.

ARTICLE VIII.—It is hereby mutually agreed between the parties hereto that the sum to be paid by the Company to the Contractor for said work and materials shall be.....
.....
subject to additions and deductions as hereinbefore provided, and that such sum shall be paid in current funds by the Company to the Contractor in installments, as follows: .....
.....
.....

Provided, said Contractor shall first furnish to said Company or Engineer, all receipts, vouchers, affidavits and schedules, required by state and municipal laws and ordinances; also waiver of lien, claim or right of claim of said Contractor or sub-contractors.

It is especially understood and agreed that the amounts to be paid from time to time shall in no case exceed eighty-five per cent. of the value of work done and materials furnished, the remaining fifteen per cent. of said value to be retained by said Company as part security for the faithful performance of this contract, and not to be paid until on expiration of thirty days after the perfect completion of said work and the payment of all claims for labor and materials furnished.

The final payment shall be made within thirty days after this contract is fulfilled.

All payments shall be made upon written certificates of the Engineer to the effect that such payments have become due.

If at any time there shall be evidence of any lien or claim for which, if established, the Company might become liable, and which is chargeable to the Contractor, the Company shall have the right to retain

out of any payment then due or thereafter to become due an amount sufficient to completely indemnify him against such lien or claim. Should there prove to be any such claim after the payments are made, the Contractor shall refund to the Company all moneys that the latter may be compelled to pay in discharging any lien on said premises made obligatory in consequence of the Contractor's default.

ARTICLE IX.—It is further mutually agreed between the parties hereto that no certificate given or payment made under this contract, except the final certificate or final payment, shall be conclusive evidence of the performance of this contract, either wholly or in part, and that no payment shall be construed to be an acceptance of defective work or improper materials.

ARTICLE X.—The Contractor shall during the progress of the work maintain full insurance on said work, in his own name and in the name of the Company, against loss or damage by fire; the policies shall cover all work incorporated in the building, and all materials for the same in or about the premises, and shall be made payable to the parties hereto as their interest appear. And said Contractor assumes all responsibility for any loss or damage that may happen to said work thereof, or to the materials therefor, of for any injury to the workmen or the public or any individual or for any damage to adjoining property. It is further agreed that the Company shall not in any manner be answerable or accountable for anv violation of the city ordinances.

ARTICLE XI.—The said parties for themselves, their heirs, executors, administrators and assigns, do hereby agree to the full performance of the covenants herein contained.

IN WITNESS WHEREOF, the parties to these presents have hereunto set their hands and seals, the day and year first above written.

In presence of

.....[SEAL.]
.....[SEAL.]
.....[SEAL.]

SPECIFICATIONS.

Specifications may be divided into three classes:

(1)—Those accompanying complete detail plans.
(2)—Those accompanying general plans.
(3)—Those unaccompanied by any plan.

A printed form would naturaly fit the first class most easily. This form should embody the essential parts of a specification as given on page 88 of Johnson's book.

Almost every stationer carries in stock printed specifications. These give fairly good satisfaction when the class of building they are supposed to cover is not deviated from or any large amount involved. They are of necessity broad, and wrong in the principle, because the Contractor is told what you do not want instead of clearly what you do want.

For small stations costing $5,000, it is possible to use printed specifications also; there is no doubt economy in their use where a great many buildings of approximately the same class are to be duplicated.

For more expensive stations, however, a general printed form should be supplemented by typewritten specifications of the various trades. Of

these trades it would probably be practical to standardize cement work, foundation masonry, painting, glazing, possibly the carpentry work also, using the Underwriters' Specifications for electric wiring. However, the brick and tile work, hardware, plastering, heating, ventilation, plumbing, sewerage, and sheet metal work would have to be subdivided into classes or varied to suit conditions.

The tendency to-day does not seem to be along the line of standardizing either plans or specifications. This was formerly a comparatively simple matter, as the kind of building material was limited, and wood was much cheaper than brick or stone. The simple board and batten station, with wide bracketed eaves, was as much of a railroad standard as the passenger coach. However, the growth of public taste has demanded a passenger station that shall be roomy, modern and comfortable, and conform to the the laws of architecture. In this we are following European practice where every passenger station is the architectural pride of the community.

Respectfully submitted,

H. W. PARKHURST, Engineer B. & B., Illinois Central Railroad, Chicago, Ill., *Chairman;*

A. R. RAYMER, Asst. Chief Engineer, Pittsburg & Lake Erie Railroad, Pittsburg, Pa., *Vice-Chairman;*

E. DB. BROWN, Architect, Lehigh Valley Railroad, New York, N. Y.;

H. W. COWAN, Chief Engineer, Colorado & Southern Railway, Denver, Colo.;

B. C. GOWEN, Chief Engineer, Wisconsin & Michigan R. R., Peshtigo, Wis.;

E. C. MACY, Prin. Asst. Eng., Chicago Great West. Ry., St. Paul, Minn.;

W. S. NEWHALL, Chief Engineer, Wabash Railroad, St. Louis, Mo.;

L. D. SMITH, Building Supervisor, G. C. & S. F. Ry., Galveston, Texas,

Committee.

DISCUSSION.

Mr. Walter G. Berg (Lehigh Valley—by letter):—Under the head of definitions there is one question in this report that should receive thorough discussion and some authoritative action, namely, the uses and definitions of the words "depot" and "station." Some of the roads of the country have placed a ban on the word "depot" and use the word "station" for the stopping-place, and differentiate further by using the terms "passenger station," "freight station," "combination station," etc. The definitions, as given by the Committee, are not concise, complete or sufficiently distinctive, and do not correspond to any generally accepted practice.

Under the head of Passenger Stations, the most general question liable to cause discussion is whether one general waiting-room or separate waiting-rooms are preferable. This is one of the open questions in designing local passenger stations. The method of having nominally two waiting-rooms connected by a passageway, sometimes open and in other cases with a light swinging door, is neither one thing nor the other. It is preferable to take the same ground space and give one general waiting-room and then provide a large, airy, comfortable ladies' retiring-room, back of which would be the ladies' toilet. Furnish this ladies' room comfortably, put in rockers, mirrors and other paraphernalia dear to the feminine mind and suggestive of home comforts, and you have taken a long step toward securing travel for the road.

In connection with toilet-rooms, the Committee has not discussed the question of the entrances to same. They should never open out of the general waiting-room. The ladies' toilet should open from a separate ladies' retiring or lounging room.

There is one clause of the Committee's report which is not clear as to what the Committee desires to have inferred. The Committee states that "a great deal of ingenuity has been manifested in the construction of stations in which no room has been wasted for halls and vestibules." Does the Committee believe that this is a good or bad feature?

Mr. W. McNab (Grand Trunk—by letter):—The writer would respectfully suggest a few alterations in the wording and sense of some of the paragraphs in the report, as follows:

The clause relating to the use of out-freight houses to be amended in order to read: Out-freight houses are used for the receipt of freight from local sources which is intended to be placed on cars and shipped to various stations.

Section 3 of the clauses relating to essential conveniences in passenger stations to be supplemented by the following: At large terminals there should be a Bureau of Information separate from the ordinary ticket office.

The second clause relating to specifications to be amended by substituting the words "*Engineering Contracts and Specifications, by J. B. Johnson,* 1898," for the words "Johnson's Book."

The third clause to be changed in order to read: "Printed forms of specifications can generally be obtained from a stationer, but frequently the value of such specifications is lessened by reason of works not specially required usually having more prominence than those that are actually necessary."

The last sentence in the last paragraph of the report to be amended in order to read: "In this we are following the general European practice, in which it is the endeavor to make passenger stations architecturally attractive and in harmony with the natural surroundings of the community."

Mr. J. P. Snow (Boston & Maine—by letter):—A prescription for a standard passenger station would be a deplorable outcome of the Committee's work. It is seldom that local conditions at different places are precisely similar, and nothing looks worse or is less economical than a building not adapted to its surroundings or the uses for which it is needed. But while our buildings can not well be standardized, the scheme on which they are designed can be.

The underlying principles governing the design of passenger stations on the Boston & Maine Railroad, of the size covered by the report, are, to furnish a single waiting-room, common to the two sexes; to have a women's dressing-room and two toilet rooms, a baggage room, and generally a telegraph room and express room. No combined freight and passenger stations are built for towns so large as specified. The waiting-room occupies the end of the building next to the street, and the building should be so placed that this will be the sunny portion. The other rooms are bunched at the other end of the building, so arranged that the women's toilet will be entered from the dressing-room, and the men's toilet from a passage, so that the doors will not be adjacent. The entrance to the men's closet is, however, always from the waiting-room—never from the outside of the building. The baggage room has a door opening from the waiting-room for convenience in checking hand baggage. This door is generally made a "Dutch" door, that is, the upper and lower halves swing independently, the lower part having a shelf on the waiting-room side. The water closets are placed close together for economy of plumbing.

In case a telegraph room is not provided separate from the ticket office, the latter is set out in the manner of a bay window, so that the operator can see each way on the track, and an opening separate from the ticket wicket is provided so that trainmen in getting orders will not need to occupy the ticket window. Stations of this size are generally provided with a generous express room, nearly always larger than the baggage room.

These buildings are provided with a cellar in which the hot-water heating plant is located, with coal bins, etc.

Such features are standard with us. The walls may be brick or wood, the roofs slate, tile or shingles, and the finish plain or elaborate, as the locality demands. No two are built exactly alike. Some need extra large express rooms, some unusually large baggage rooms, some need ticket rooms to accommodate several clerks, and others only the ticket seller, and a few near the international boundary need a separate waiting room for immigrants. We do not find a smoking-room essential. Where they are provided, they are but little used. The women's dressing-room may be small, not over 80 or 100 square feet. It should contain a wash bowl, a mirror and two chairs. It serves also as a vestibule to the toilet room.

Regarding specifications and contracts, it has been my experience that specifications should be written for each building, but I see no reason why a standard form of contract can not be adopted and used in printed form.

I heartily agree with what the Committee says about the undesirability of burdening a contract with what should be, and quite likely is, in the specification. I strongly object, also, to the common practice of padding a contract with extracts from the code of common law. A contractor is amenable to the local laws, whether or not his attention is called to them in the contract; moreover, we can not make law by writing mandates in the agreement. Another common defect in contracts is the writing into them of one-sided demands; the sample offered by the Committee is not wholly free from this fault, as witness the last paragraph of Article IV., where the contractor is required to have on the job at all times a capable man to receive orders from the engineer, but nothing is said about the engineer having a man on hand to interpret the plans and specifications so that the contractor may not be delayed. Another instance is the middle paragraph of Article VII., where a per diem damage is assessed for failure to complete the work on time, with no equivalent bonus if the work is completed ahead of time. It has been held by the courts that such damages do not exist in law unless the advantage of early completion is worth paying a bonus for. A seal against a signature does not compel a man to pay what is not collectable by law.

I object to the last paragraph of Article I., as it seems to infer that a specification should repeat what is shown on the drawings. I claim that a specification should not be loaded down with dimension figures and data that can be better shown on the plans, and that a plan should not be obscured by notes and descriptions that can better be written in the specification. The plans should show what is to be built, the specification should describe the material and workmanship, and the contract should set forth the agreement for executing the work. There should be no repetition or duplication. Each should be as concise as possible; the specifications, however, should be full enough to describe everything in detail. The contract may well be shorter than the form submitted by the Committee, although the essence of nearly all the articles given is essential. The wording of several could no doubt be improved

MR. C. S. CHURCHILL (Norfolk & Western—by letter):—In my estimation the proposed form of contract and specifications, generally speaking, is a good one; but there are certain legal features that must be covered in any contract drawn up for buildings and other structures, the phraseology of which is generally determined by the legal department of the railway companies, and some of the phrases may differ somewhat in some sections of the country. In this connection, to illustrate my point, I submit a contract form that has been in use by this company for a number of years covering the construction of buildings, bridges, wharves, docks, isolated pieces of masonry, and almost every form of construction that comes up on a railroad, excepting grading and masonry, for which we have a special form of contract and specifications combined. This contract is used by inserting after the first page the specifications for the structure under consideration.

NORFOLK AND WESTERN RAILWAY COMPANY.

CONTRACT.

Articles of agreement, made and concluded this ..... day of ..... A. D. 190.., by and between ..... of the first part, and the Norfolk & Western Railway Company, of the second part, witnesseth:

I. That for and in consideration of the covenants and payments hereinafter mentioned, to be made and performed by the said party of the second part, the part.. of the first part hereby covenant.. and agree.. to complete, in the most substantial and workmanlike manner, to the satisfaction and acceptance of the Engineer of the said Company,

....
....
....

of said Railway Company, said work to be done and finished agreeably to the directions and orders of the said Engineer of the Norfolk & Western Railway Company, or his Assistants, on or before the..... day of ....., A. D. 190.., and according to the specifications as follows, to-wit:

SPECIFICATIONS.

II. The part.. of the first part agree.. so to conduct the erection of ..... the ..... structure ..... as not to interfere with the passage of trains of the party of the second part, and without causing delay to same.

III. No charge or claim shall be made by the Contractor for hindrances or delay from any cause in the progress of any portion of the work in this Contract, whether for want of Right of Way, litigation or otherwise, but these may entitle him to an extension of time allowed for completing this work sufficient to compensate for the detention, to be determined by the Engineer in charge, provided immediate notice in writing of the cause of the detention has been given to the party of the second part and to the said Engineer, nor shall any claim or claims be allowed for extra work, unless the same shall be done in pursuance of an order in writing from the Engineer in charge, and the claims made at the first settlement after the work was executed, unless the Engineer at his discretion should direct the claim or such parts as he may deem just and equitable to be allowed.

IV. The quantities exhibited to the Contractor at the time of soliciting proposals for the work herein contracted for are necessarily only approximate, and they furnish only general information, and will in no way govern or affect the final estimate, which will be made out on the completion of the work from actual measurements and established facts not determinable at the time of letting the work.

V. And the said party of the second part does promise and agree to pay the said part.. of the first part for work done and materials furnished by ..... under this Contract as follows, to-wit:

....

....

....

VI. Payment is to be made by the party of the second part for work done and materials furnished under this Contract, on or about the fifteenth day of each month, upon proper estimates rendered on the last day of the preceding month, for work done and materials furnished during the preceding month, to the extent of and not beyond 85 per cent. of the amount of such estimates, and such monthly estimate, to be valid, must be accompanied by the certificate of the Engineer of the Company, approving the same and declaring that the work done and materials furnished, as therein stated, are according to this Contract, and that the charges for the same are according to this Contract; and without such certificate, no estimate shall be valid, and no payment can be demanded, and in all questions connected with such estimates and the amounts payable thereby and thereunder, the decision of the said Engineer shall be final and conclusive on all parties; and the balance thereof, or the 15 per cent. remaining due on such estimates, shall not be payable until the whole work to be done under this Contract has been fully completed, but shall be kept back as part of the security for the performance of this Contract on the part of the part.. of the first part.

VII. When the Engineer in charge has furnished his certificate that all the work embraced in this Contract has been completed agreeably to the specifications, and in accordance with the directions, and to the satisfaction and acceptance of the said Engineer, there shall be a final estimate made of the quality, character and value of said work, according to the terms of the Agreement, when the balance appearing due to the said part.. of first part, according to the certificate of the said Engineer, shall be paid to ..... within thirty days thereafter, upon ..... giving a release, under seal, to the party of the second part, from all claims or demands whatsoever, growing in any manner out of this Agreement, and upon ..... procuring and delivering to the party of the second part, full release in proper form, and duly executed, from mechanics and material men, of all liens, claims and demands for materials furnished and provided, and work and labor done and performed upon or about the work herein contracted for under this Contract.

VIII. It is further covenanted and agreed between the said parties, that the said part.. of the first part shall not sub-let or transfer this Contract or any part thereof to any person (excepting for the delivery of material) without the written consent of the Engineer, but will at all times give personal attention and superintendence to the work.

IX. It is further agreed and understood that the work embraced in this Contract shall be commenced within ..... days from this date, and prosecuted with such force as the Engineer shall deem adequate to its completion within the time specified, and if at any time the said part.. of the first part shall refuse or neglect to prosecute the work with force sufficient, in the opinion of the said Engineer, for its completion within the time specified in this Agreement, then, and in that case, the

said Engineer in charge, or such other agents as the Engineer shall designate, may proceed to employ such a number of workmen, laborers and overseers as may, in the opinion of the said Engineer, be necessary to insure the completion of the work within the time heretofore limited, at such wages as he may find it necessary or expedient to give, pay all persons so employed, and charge over the amounts so paid to the part.. of the first part, as for so much money paid to ..... on this Contract, or for the failure to prosecute the work with an adequate force, for non-compliance with his directions in regard to the manner of constructing it, or for failure to complete the work within the time, according to the terms of this Agreement, or for any other delay in the performance of, or any omission, or neglect of the requirements of this Agreement, and specifications on the part of the part.. of the first part, the said Engineer may, at his discretion, declare this Contract or any portion or section embraced in it forfeited, which declaration shall exonerate the said Company from any and all obligations and liabilities arising under this Contract, the same as if this Agreement had never been made, and the part.. of the first part shall not be entitled to the payment of the reserved percentage of fifteen per cent. upon any work done by the part.. of the first part, and the reserved percentage upon any work done by the part.. of the first part may be retained forever by the party of the second part.

X. The said part.. of the first part ha.. further covenanted and agreed to take, use, provide, and make all proper, necessary, and sufficient precautions, safeguards, and protection against the occurrence or happening of any accidents, injuries, damages, or hurt or delays to any person or property during the progress of the construction of the work herein contracted for, and to be responsible for and to indemnify and save harmless the said party of the second part, and the said Engineer, for the payment of sums of money by reason of all or any such accidents, injuries, damages, or hurts or delays that may happen or occur upon or about said work, and from all fines, penalties, and loss incurred for and by reason of the violation of any city or borough ordinance or regulation, or law of the State, or the United States, including all claims, litigation, expenses, damages, losses or liability while the said work is in process of construction.

XI. If in the performance of this Contract, or any part hereof, the party of the second part shall be or become subject to any claims, litigation, expenses, or damages, losses or liability by reason of any act or default or negligence of the part.. of the first part, or any of ..... agents or employés, then the party of the second part shall have the right, by way of set-off or defalcation, at any time or times, to withhold and retain such sums of money—current and other estimates and all payments—which may or might otherwise be or become payable by the party of the second part hereunder, to the part.. of the first part, whether growing out of the same or another piece of work, construction, or transaction hereunder, as may in the opinion of the party of the second part, be necessary to reimburse or indemnify the party of the second part against all such claims, litigation, expenses, damages, losses or liability, whether the same shall or shall not have been definitely liquidated or ascertained, or shall or shall not be in dispute or litigation; and to apply the sums of money so retained, or so much thereof as may be ultimately found necessary to reimburse and indemnify the party of the second part.

XII. It is further understood and agreed that the party of the second part may, at any time, either with or without an estimate furnished, pay directly to the employés and others having claims and demands against the part.. of the first part, for work done and materials furnished to

the part.. of the first part for the purposes of this Contract, and may at any time require vouchers for the payments to employés and others having claims and demands against the part.. of the first part, for work done and material furnished to the part.. of the first part for the purposes of this Contract.

XIII. If, during the progress of the work herein contracted for, work should be done under the direction of the Engineer, which cannot, in the opinion of the Engineer, be accurately measured or estimated for under the terms of this Contract, then, and in that case, the same shall be paid for at actual cost for labor and materials furnished by the part.. of the first part, with ..... per cent. added for superintendence and use of tools, and it is further agreed and understood that all the terms and stipulations of the Contract shall apply to all work so done, which for all purposes shall be deemed part of the work contracted for by the part.. of the first part.

XIV. It is further understood and agreed, that wherever the word Engineer has been used in this Contract, it relates to and means the Engineer Maintenance of Way of the Norfolk & Western Railway Company.

XV. It is further agreed that time shall be of the essence of this Contract, and shall not be relievable against in equity or at law.

WITNESS the hands and seals of the respective parties hereto, this ..... day of ..... Anno Domini nineteen hundred and .....

WITNESSES:

..... [Seal]
..... [Seal]
..... [Seal]
..... [Seal]

NORFOLK AND WESTERN RAILWAY COMPANY,
By.....

ATTEST:

.....
Secretary.

MR. E. H. MCHENRY (Canadian Pacific—by letter):—I concur in the conclusions of the Committee regarding the impracticability of establishing standards for station building. Attached hereto is our standard form of building contract, which contains some clauses which might be profitably inserted in the proposed form.

In our practice I have always found it desirable in securing proposals to have unit prices fixed for the principal items entering into construction, to be used in determining additions or deductions from the contract price, when structural alterations become necessary. This precaution will very considerably simplify the application of Article No. 3 in the proposed form of contract.

This Agreement, made in duplicate the ..... day of ....., 190.. between ....., hereinafter called "the Contractor," of the one part, and THE CANADIAN PACIFIC RAILWAY COMPANY, hereinafter called "the Railway Company," of the other part, witnesseth as follows:

(1) In consideration of the covenants and agreements hereinafter contained and to be performed by the Railway Company and of the prices hereinafter mentioned the Contractor hereby covenants and agrees with the Railway Company that he will furnish all labor, services and material required by this contract, and will construct, complete and finish

in the most thorough, workmanlike and substantial manner in every respect to the satisfaction and approval of the Chief Engineer for the time being of the Railway Company, in the manner herein specified and limited and according to the Plans and Specifications hereto annexed, and which, for the purposes of identification, have been signed by the Contractor and the Secretary of the Railway Company and form part of this contract, and will, on or before the ..... day of ..... next (time being of the essence of the contract), finally complete and deliver to the Railway Company the following work, that is to say:

.....

.....

it being understood that if anything has been omitted from or has been misstated, in the plans or specifications which is necessary for the proper performance and completion of any part of the work contracted for, the Contractor shall, at his own expense, execute the same as if it had been inserted and properly described as the case may be, and the correction of any such error or omission shall not be deemed to be an addition to or a variation from the works hereby contracted for.

(2) The Railway Company or its Chief Engineer shall appoint a representative of the Railway Company on the work, and such representative, or any substitute, and any assistant duly appointed by such representative or substitute shall, in this agreement and in the specifications, be referred to as "the Engineer."

(3) The said work shall be commenced immediately after the execution of this agreement, and shall be proceeded with continuously and diligently and under the personal supervision of the Contractor until completed. The work shall be carried on and prosecuted in all its several parts in such manner and at such times and at such points or places as the Engineer shall from time to time direct and to his satisfaction, but always according to the provisions of this agreement, and if no direction is given, then in a careful, prompt and workmanlike manner according to this agreement.

(4) This agreement shall not be assigned, nor shall the said work or any part thereof be sub-contracted without the written consent of the Engineer to every such assignment or sub-contract.

(5) The Contractor will in all things conform to and comply with the instructions of the Engineer. All work or material which, in the opinion of the Engineer, is imperfect or insufficient shall be remedied when pointed out to the Contractor by the Engineer, and will be made good and sufficient by the Contractor at his own expense and to the satisfaction of the Engineer, who shall have the power, and whose duty it shall be, to have any defective work or material taken out and rebuilt or replaced at the expense of the Contractor. Any omission by the Engineer to disapprove of or reject any insufficient or imperfect work or material at the time of any estimate shall not be deemed an acceptance of such work or material.

(6) The Contractor will not bring or permit to be brought anywhere, on or near the said work, any spirituous or intoxicating liquors, and if any foreman, laborer or other employé or contractor shall, in the opinion of the Engineer, be intemperate, disorderly, incompetent, wilfully negligent or dishonest in the performance of his duties, he shall, on the direction of the Engineer, be forthwith discharged, and the Contractor shall not employ or permit to remain upon the work any person who shall have been discharged from the said work for any or all of the said causes.

(7) No extra work or material is to be allowed or paid for, excepting only upon a previous order in writing of the Engineer and any and

all claims for extra work or material must be presented to the Engineer for allowance at the close of the month in which the same shall have been done or furnished and shall be included in the estimate for that month, otherwise all claims therefore shall be deemed absolutely waived by the Contractor, and the Railway Company shall not be required to allow or pay for the same, but may exercise its option concerning such payments.

(8) Whenever in the opinion of the Engineer it is necessary or expedient for the Railway Company, that the said work or any portion of it should be stopped, or that the force employed thereon should be diminished, the Railway Company may stop such work or diminish such force, and upon being requested in writing to do so by the Railway Company, the Contractor shall stop the work or reduce the force, as the case may be, in accordance with such written request, and the Contractor shall have no claim for damages by reason thereof. Such writing shall be signed by the Engineer and delivered to the Contractor or to some person on the work representing the Contractor at least thirty days previous to such required stoppage of work or reduction of force.

(9) If at any time before the completion of this contract the Contractor shall not be progressing with the said work with sufficient diligence to satisfy the Engineer, or, in the opinion of the Engineer with sufficient force to ensure its progress and completion within the time or times required by this agreement, the Engineer may order and direct the Contractor to put on and employ such additional force and means as, in the judgment of the Engineer, shall be sufficient to complete the said work and each portion thereof within the specified time, and upon the refusal, failure or omission of the Contractor to comply with such order and directions within one week from the giving of the same, the Engineer may declare this contract abandoned by the Contractor, and, in that case, the moneys which may then remain unpaid, and which would otherwise be payable to the Contractor under this agreement, including the percentage retained on all estimates, may be kept, retained and appropriated by the Railway Company, in its own right absolutely, and the Contractor shall have no claim to the said moneys or to any part thereof, and the Railway Company may employ such force and means as in the judgment of the Engineer or Chief Engineer shall be necessary to complete said work and the cost and expenses connected therewith, and all damage suffered by the Railway Company by reason of such failure on the part of the Contractor shall be charged to and be paid by the Contractor.

(10) The Contractor shall promptly pay for all labor, services or material used in or about the construction of the work, and all payments for such purposes shall be made by the Contractor at least as often as payments are made by the Railway Company to the Contractor, and, in the event of failure by the Contractor at any time to do so, the Railway Company may retain from all moneys due or to become due to the Contractor such amount of moneys as the Chief Engineer or the Engineer may deem sufficient to pay for the same or to secure the Railway Company from loss by such non-payment. Before final settlement is made between the parties hereto for work done and materials furnished under this contract, the Contractor shall and will produce and furnish evidence satisfactory to the Railway Company that the said work and any other property of the Railway Company upon which such work may have been constructed and all structures are free and clear from all liens for labor, workmanship, materials or otherwise and that no claim then exists in respect of which a lien upon the said work or property of the Company could or might attach. And the Contractor shall protect and hold harmless the Railway Company and all its property from any and all kinds

of liens accruing for labor and services performed and material furnished or otherwise and any of the same in or about the said work.

(11) The Contractor shall be at the risk of and shall bear all loss or damage whatsoever and from whatsoever cause arising which may occur on the work until the same be fully and finally completed, delivered to and accepted by the Railway Company, and if any loss or damage occur before such final completion, delivery to and acceptance by the Railway Company, the Contractor shall immediately, at his own expense, repair, restore, and re-execute the work so damaged or which may have been destroyed.

(12) The Contractor and his agents, laborers and all others in his employ or under his control shall use due care that no person or property is injured or any rights infringed in the prosecution of the said work, and if any damage to any person or property occurs in or about the said work, or if any right is infringed by any act or neglect of the Contractor or of his agents, laborers or other employés, the damages or compensation therefor shall be paid by the Contractor, and together with any costs or expenses incurred in adjusting the same may be deducted by the Railway Company from any moneys due or to become due to the Contractor.

(13) If there be any stoppage of the said work upon the written direction of the Railway Company, or if its progress be materially delayed by reason of any act or neglect of any of the Engineers, agents or employés of the Railway Company the time herein specified for completing the said work shall be extended for a period equal to the time of such stoppage or delay, and the Contractor shall have no further or other claim therefor, or from anything arising therefrom or caused thereby. The right of the Contractor to such extension shall be deemed to have been waived unless a claim therefor, stating the occasion and nature thereof, shall be made by him in writing delivered to the Railway Company at the time of such stoppage or delay.

(14) In case of a total suspension of all work under this agreement without any fault, default, collusion, or procurement of the Contractor for a longer period than ..... days, unless such suspension shall have been caused by the winter season or protracted rigor of weather, it shall be the duty of the Engineer to make a final estimate of the work done according to the terms of this agreement and to make a return thereof to the Railway Company, when the amount found by the Engineer to be then due for work done, together with all percentage retained up to that time, except as herein otherwise provided, shall be paid to the Contractor.

(15) Any damage by fire that may occur to buildings or structures during construction, must be made good by the Contractor, who must keep such structures fully insured until the same have been completed and accepted by the Railway Company. The operation or occupation by the Railway Company of a portion of the work before the completion of the whole, is not to be considered as an acceptance of the same by the Railway Company. The premiums for fire insurance provided for herein shall be divided equally between the parties hereto and the policies are to be in the names of both parties, the loss being made payable as their interests may appear and the policy or policies shall be deposited with the Chief Engineer of the Railway Company.

(16) In consideration of the faithful performance by the Contractor of all and singular the covenants and agreements herein contained, the Railway Company hereby covenants and agrees with the Contractor that it will well and truly pay to him on the full completion by him of all the work embraced in this agreement, in the manner and within the time herein specified and limited for the completion thereof to the satisfac-

tion and subject to acceptance by its Chief Engineer, and subject also as herein provided the following sums and prices, namely:

. . . . . .
. . . . . .
. . . . . .

(17) In addition to the foregoing contract price the Railway Company shall pay to the Contractor for extra work or for work done under written orders of the Engineer, not covered by this agreement but done in the proper execution of this contract and for which prices are not named herein, the actual cost of such work, with an additional ten per cent. upon the cost of labor and material for use of tools, contractor's plant, superintendence and profit. But such actual cost shall not exceed the reasonable market value of such labor and material as the case may be.

(18) Approximate estimates of the work done under this contract are to be made at the end of each calendar month by the Engineer, and payments thereon shall be made by the Railway Company to the Contractor on or about the twentieth day of the next ensuing month, less all previous payments, and less ten per cent. of the amount of each and every such monthly estimate, which last mentioned percentage may be retained by the Railway Company as an additional security for the performance of this contract by the Contractor until the same has been completely performed.

(19) When, in the opinion of the Chief Engineer of the Railway Company, this agreement has been completely performed within the time herein provided, subject to the foregoing provision as to extension, he shall certify the same in writing under his hand, with a final estimate of the work done by the Contractor and a statement of the amount due and unpaid, and the Railway Company shall, within sixty days after such completion, pay to the Contractor the full amount which shall be so found due, including the percentage retained on former estimates as aforesaid, except as in this agreement is otherwise provided upon delivery by the Contractor to the Company, if required, of a good and valid release and discharge of and from any and all claims and demands for and in respect of all matters and things growing out of or connected with this contract or the subject-matter thereof and of and from all claims and demands whatsoever.

(20) The right is hereby reserved by the Railway Company at any time to change and alter in whole or in part as to it may seem expedient, the works embraced in this agreement, and any change or alteration of the works shall not affect the prices herein specified, nor shall any bill for extras or other charge or claim be made, allowed or paid by reason thereof or of any difference occasioned by such change or alteration in the quality, locality or nature of the work to be performed, but if the Chief Engineer shall deem the change or alteration of the works to have materially affected the cost of doing the work he shall fix or determine the price to be paid either above or below, as the case may be, the prices hereinbefore provided to be paid for such work so as to do substantial justice to both parties.

(21) It is hereby declared and agreed to by the Contractor that this agreement is made and entered into by him for the consideration herein expressed solely on his own knowledge and upon information derived from sources other than the Railway Company, its officers or agents, of and respecting the nature and formation of the property upon which the said work is to be done, or the character, quantities or location of the material required to be removed, and that the Contractor does not rely upon any information given, or statement made, to him in connection with the said contract by the Railway Company or any of its officers or agents.

(22) If the Contractor shall, at any time, fail, omit or refuse to comply with or perform any of the provisions of this agreement, which, on his part, are to be observed or performed, the Railway Company may cancel and annul this contract, in which event the Contractor shall have no claim or demand whatever upon or against the Railway Company for damages, or for compensation for work done, or material provided, or for any portion of the said percentage retained on any estimate, and the Railway Company may take possession of and hold the said work and all materials furnished under this agreement, and may retain and appropriate to its own use all moneys which may then be unpaid to the Contractor, including the said percentage, and the Railway Company shall be absolutely and forever released from all liability therefor to the Contractor.

(23) In order to prevent disputes or misunderstandings between the parties hereto in relation to any of the stipulations and provisions contained in this agreement, or the true intent and meaning thereof, or the manner of performance thereof, or of any part thereof by either of the said parties, and for the speedy settlement of such as may occur, the Chief Engineer for the time being of the Railway Company shall be, and he hereby is, made, constituted and appointed sole umpire to decide such questions and matters, including the amount and quantity, character and kind of work performed and materials furnished by the Contractor, and all extra work and material. The decisions of the Chief Engineer, which may be given from time to time as the questions come up, shall be binding and conclusive upon both parties hereto.

(24) Wherever, in this agreement, it is stipulated that anything shall be done or performed by either of the parties hereto it shall be assumed that such party has thereby entered into a covenant with the other party to do or perform the same, and that such covenant is entered into, not only by, for, or on behalf of the parties hereto, but is also entered into by and on behalf of their respective executors, administrators, successors and assigns. And whenever this agreement is entered into by more than one person as parties of the first part the word "contractor" shall be read "contractors," and the pronouns referring to the contractor shall be read as plural; and whenever a corporation is the party of the first part the said pronouns shall be varied accordingly.

In witness whereof the parties hereto have herewith caused these presents to be signed and sealed on the day and year first above written.

Signed, sealed and delivered by the
Contractor in presence of

....

Signed, sealed and delivered by the
Railway Company in presence of

.....L. S.

Signature of Contractor.

Mr. W. C. Cushing (Pennsylvania Lines—by letter):—I beg to offer the following criticisms on the report of the Committee No. 6, on Buildings:

DEFINITIONS.

Roundhouse.—I do not believe so many definitions of the term round house which do not apply to railroads are necessary. I think the term enginehouse is preferable, and submit the following suggested change:

Enginehouse.—On American railroads, a building approximately round or segmental, or of rectangular form, built of wood or brick, having

stalls for the storage or repairing of locomotives and their tenders, with tracks leading from the stalls to a central turntable or transfer table.

TURNTABLE.—I recommend the following change from the Committee's definition: A revolving platform placed on girders of wood or iron, usually located in a circular pit and used either for reversing engines or cars, or to receive them from one track or set of tracks for delivery to others radiating from the center.

TRANSFER TABLE.—A rolling or sliding platform on which cars, engines, etc., may be run to be carried transversely across from one track or set of tracks to another. Such a table is usually constructed to provide connection between parallel tracks leading into a rectangular building or area for the construction, storage or repair of engines, cars or other apparatus designed to travel on railroad tracks.

CINDER PIT.—I think this term should be changed to Ash Pit, and I favor the following definition: A place for cleaning out the ash pans of locomotives, including generally the apparatus for removing ashes and loading them on cars.

WATER CRANE.—Synonyms for water crane are water column, standpipe and pen-stock.

CONTRACT AND SPECIFICATIONS.

I agree with the Committee that general specifications can not be drawn up which will cover all of the varieties of building work in railroad engineering, but as the Committee says, the agreement form is distinctive and can be made standard, and there are also general specifications outlining the mutual responsibilities between the engineer and contractor which can also be made more or less standard. As we have lately been revising our general contract form and general specifications, I can not express my ideas on the matter better than by submitting copies herewith for the consideration of the Committee. I have read over the Committee's specifications and find some omissions in them which I think it well to include. Some of the material which the Committee puts under the head of General Contract finds a more logical place under the head of General Specifications.

PENNSYLVANIA LINES WEST OF PITTSBURGH.

GENERAL SPECIFICATIONS.

Forming a Part and Parcel of all Specifications.

The word Contractor is herein used to designate the person or persons undertaking work under these specifications and drawings.

The word Company is herein used to designate the Company employing the Contractor.

The word Engineer signifies the Chief Engineer of the Pennsylvania Lines West of Pittsburgh, or his assistant or any person deputed to inspect the work. The Engineer will give any interpretation of the specifications required by the Contractor, and when there is any doubt upon any point, the Chief Engineer's decision as to the true intent and meaning of the drawings and specifications is to be final and without appeal.

The plans will be considered as part of the specifications and illustrative of same. Figures when marked on plans to be preferred to scaled dimensions. Additional detail drawings needed during the progress of the work will be furnished and are to be considered as part of the specifications. All plans to be returned to the Engineer upon completion of the work.

The Engineer reserves the right to make any changes in the plans and specifications he may deem desirable. Should any additional labor or material be involved in such changes, the contractor shall be paid for supplying the same; on the other hand, should any such changes reduce the amount of labor or material in the work as designed, the Contractor shall sustain an equivalent reduction in his contract amount. The Engineer shall be the sole arbiter in determining rates of increase or reduction that may be therein involved.

In no case shall any part of the work be sub-let without the approval of the Engineer.

The Contractor shall at an early date put himself in communication with other contractors whose work may affect his, so as to promote harmony of work, any difference of opinion being arbitrated by the Engineer.

The work will be carried forward in such a manner and with such progress as the Engineer will direct. The Contractor will give his personal attention to the work, and shall be represented by a foreman at all times of his absence.

The quality of all materials and workmanship is to be subject to the approval of the Engineer. Where material or labor of a specific quality is not mentioned in the Specifications, first-class material and workmanship only to be used.

The Engineer reserves the right to require the removal of any particular workman or workmen on the work, if, in his judgment, it shall be for the best interest of the work.

No spirituous liquors shall be allowed on or near the work, nor in any house, building, or tenement, occupied and used by the workmen or others employed on the work.

All material and labor; false work, tools and appliances to complete the work as designed will be furnished by the Contractor; Contractor will carefully examine the plans and specifications before bidding and note any discrepancies or any points requiring explanation.

All work must be perfect at completion; it must be protected by the contractor until that time. Contractor will keep streets and grounds as clean as possible during the progress of the work and will not be allowed to encroach further on the grounds of the Company than directed by the Engineer.

The Contractor will remove all material and debris on completion of work, and be responsible for the work until same is finished and accepted by the Engineer.

The principal lines and grades will be given by the Engineer, but the Contractor will be required to preserve and conform to them after once given, and be responsible for and make good any work deviating from established lines and grades.

Any rights or privileges, outside of the Company's property or right of way, for setting up derricks, tools, etc., or storing material, on foreign property, must be acquired by the Contractor at his own expense and risk.

Contractors will comply with all corporation ordinances and regulations, and pay all charges of every kind for permits, use of water, etc.

Each Contractor must maintain all requisite lights, guards, temporary sidewalks and fences for the protection of his work and the safety of the premises, subject to the order of the Engineer. The work is entirely at the Contractor's risk until the same is approved and accepted, and he

will be liable for its safetv; and in case of accident, causing injury to person or property, the Contractor binds himself to obtain acquittance from or make payment in full to, party so injured or damaged in person or property (whether such person be a servant, fellow contractor, a servant of a fellow contractor, or a stranger) the amount of damages to which he or she be legally entitled by reason, or on account of, any injury received through or by reason of any act or omission of the Contractor, or any agent or employé of his, during the performance of the work hereby contracted to be done, and for which injury the Company might by law be held liable to answer in damages. And the Contractor hereby binds himself to truly defend, indemnify and forever save harmless the Company against any and all claim or claims for damages which shall be set up by reason of any such injury or damage sustained as aforesaid, including the cost of suit and reasonable attorney's fee by the Company expended in necessarily and unavoidably defending against any such claim or claims.

All royalties for patents for any infringement thereof that may be involved in the work contracted for, or in the use thereof, shall be included in the contract amount if ascertained, and the Contractor shall satisfy all demands that may be made at any time for such, and be liable for any damages or infringement thereof.

The Contractor must keep the work and material involved in this contract fully insured at all times in favor of the Company against loss by fire with a responsible fire insurance company, and before any estimate is paid to him he must satisfy the Engineer that all work already done is so insured to at least the amount of all the estimates issued up to date and to be issued at that date.

Contractor will be required to give bond, amounting to one-third of contract price, for the faithful performance of the contract. Bond will be required to be executed jointly and severally by two resident property owners, each worth at least twice the amount of bond. Contractor will be party to bond. Bond of approved surety company will be accepted.

See contract for terms of payment.

No payment will be made for material not in place, unless special arrangements are made with the Engineer. No oversight or error in the making of estimates or certificates shall relieve the Contractor from his obligations to do and complete the work according to the true intent of the drawings and the specifications. Final estimates will not be paid until the work is entirely finished and accepted by the Chief Engineer.

Each bidder must state in his proposal, in writing and in figures, without any interlineations, alterations or erasures, the sum of money for which he will supply the material and perform the work required by the drawings and specifications. He must sign his proposal with his full name and give his address. The bondsmen proposed must be named and their addresses given.

The Company reserves the right to reject any or all bids.

All bids must be made out upon blanks furnished by the Engineer, unless otherwise allowed.

CONSTRUCTION CONTRACT.

Articles of Agreement, made and concluded this ... day of ...., 1..., between the ....., by its Chief Engineer Maintenance of Way, party of the first part, and ....., Contractor.., party of the second part, whereby the said Contractor.. covenant.. and agree.. to furnish all the materials, which shall be of a good, sound and durable quality, and to construct and build and completely finish ready for use, in the most substantial and workmanlike manner. .....

.....

.....

The said work to be in all respects according to the annexed specifications and to be subject to the inspection and approval of the Chief Engineer Maintenance of Way for the time being in the employ of said Company, or of any Assistant Engineer or Inspector in the employ of said Company and placed in charge of said work.

It is mutually agreed that the work herein contracted for shall be prosecuted in such order and with such progress as said Engineer may direct; and if any circumstance, not now anticipated, should arise to induce said Company to suspend for a time further progress on the work, the said Contractor.. agree.. to suspend progress within twenty days after receiving a written notice from said Chief Engineer Maintenance of Way to do so, it being understood and agreed that said Contractor shall resume the work when the said Company is ready. It is further understood and agreed that on such suspension the Contractor.. may have the option to close and settle up for the work ..... may have done, according to the estimate of said Engineer, which estimate shall be based on the terms of this contract, considered on the relative value of the work done as compared with the whole work herein contracted for. It is further agreed on the part of said Contractor.., that in the event of any suspension of the work as aforesaid, no claim shall be made for damages that may arise incidentally out of such suspension or for anticipated profits.

The said ..... hereby covenants and agrees to pay the said Contractor , in current funds, at the City of Pittsburg, for completing this contract in all respects to the acceptance of the said Engineer, as follows: .....

.....

It is mutually agreed that the prices above specified shall be in full compensation for all materials, scaffolding, sheathing and tools, and work required to complete the same in all respects.

It is further agreed that the said Engineer may direct such extra work as may be in his opinion necessary for the work herein contracted for, and the said Contractor agree to perform all such work as so directed; and the same shall be paid for as extra work, according to the estimate of said Engineer. No claim whatever shall be allowed for extra labor or material over and above the contract amount, unless the same shall have been ordered in writing, stipulating remuneration, by the Chief Engineer. The accounts for such extra work must be rendered monthly.

On or about the twentieth of each month the said Engineer will make an estimate of the relative value of work done on the basis of this contract. This certified estimate shall be transmitted to the Comptroller, and upon a voucher being issued by him therefor, eighty-five per cent. of such estimate shall be paid at the office of the Treasurer at Pittsburg, in funds current at Pittsburg, in the same way as other dues are paid by said Company, between the 15th and 25th of the month succeeding that for which the estimate is returned. No monthly estimate will be made on unfinished work that does not amount to over one hundred dollars.

It is further covenanted and agreed by the parties hereto that when the work herein contracted for is completed to the satisfaction of said Engineer, he shall measure, classify and make a final estimate of all the work done according to the contract, and shall append to the same a certificate under his hand that the same is a just and proper estimate, and that the work embraced in the same has been done and completed, according to this contract. The said estimate shall be transmitted to the Comptroller of the said Company, who, after deducting all previous payments, shall cause a voucher to be made for the balance that may remain unpaid on said contract, which voucher shall be paid within thirty days after the making of said final estimate to the said Contractor . It is, however, expressly understood that the said Contractor , before being entitled to receive said balance, shall give a receipt in full for said balance and all

claims and demands arising under this contract, and shall also satisfy said Engineer that there are no claims for material or labor unpaid which the first party might be made liable for under any law in force at that time.

It is further agreed and understood that the work embraced in this contract shall be commenced within .... days from the date hereof, and prosecuted with such force as, in the opinion of said Engineer, may be advantageously employed on the same; and if at any time the said Contractor shall refuse or fail to so prosecute the work, or shall perform the work in an improper manner, and refuse to remedy the same, as may be required by said Engineer, then, for such failure to prosecute or for failure to perform the same in a proper manner, the said Engineer shall certify the same to the said Contractor , and thereupon the said Engineer may proceed to put on such force, tools and machinery as he may deem proper to prosecute and complete the work herein contracted for, and charge the expense to said Contractor , or the same shall be deducted from the amount that would have been due under this contract, had the same been completed by said Contractor . Or the said Engineer may relet the work to any other party, charging the expense in the same way as provided in case of employing workmen to complete the work under the immediate supervision of himself, or such assistants as he may appoint. It is expressly agreed and understood that the certificate of forfeiture by said Engineer, as before provided, shall exonerate the said Company from any and all obligations and liabilities arising under this contract to said Contractor ; and the reserved percentage shall be applicable to the payment of any deficiency in completing said work, according to the terms of this contract. A copy of certificate of abandonment shall be transmitted to the Comptroller of the said Company.

The said Contractor will fully complete and deliver to the Company the work embraced and described in this contract on or before ....., and the same shall be free of all liens, encumbrances and charges, and done to the full satisfaction and approval of the Chief Engineer.

If the same be not completed in the time specified, the sum of..... per diem shall be deducted from the contract price, as liquidated damages especially agreed upon, and not as a penalty or forfeit, for every day the completion of the work is delayed after the above specified date, which sum shall be over and above the expenses of extra material, labor and inspection already mentioned.

If, however, the progress of the work shall be delayed by any causes beyond the control of the Contractor, an extension of time may be allowed by the Chief Engineer, but claims for such extension must be made in writing by the Contractor at the time of such delay, stating its nature and extent, and the decision of said Chief Engineer thereon shall be final and binding upon both parties. No monetary allowance will be made for any delays.

In order to prevent litigation and dispute, and to provide for the prompt settlement of all questions that may arise relating to the execution of this contract, and to the measurement, classification and estimate for the same, it is hereby mutually agreed that the decision, arbitrament, classification and estimate of said Engineer shall be final and conclusive in the premises.

Mr. F. G. Jonah (St. Louis, Brownsville & Mexico Railroad—by letter) :—As to the Committee's statement that "a great deal of ingenuity has been manifested in the construction of stations in which no room has been wasted for halls and vestibules," the writer believes that it is a question of climate as to whether these are desirable or not.

In the North they certainly are, as the waiting rooms can not be kept comfortable in the winter time without them; while in the South they are not necessary for this purpose, and it is preferable to omit them.

MR. HUNTER MCDONALD (Nashville, Chattanooga & St. Louis—by letter):—The writer does not understand that in defining terms used by our profession it is necessary to quote definitions from standard works. It would seem within the province of this Association to create terms to express certain things where none already exist, and to supply its own definitions to terms already in use about the meaning of which there is some confusion. The following changes in definitions appear desirable:

The definition of the word "building," as given by the Committee, is not the one understood by American railway engineers, nor will any definition except that fixed by the Interstate Commerce Commission, in its classification of operating expenses, be acceptable. The definition given by the Interstate Commerce Commission is arbitrary and covers many things to which the Committee's definition could not be applied. The definition of this word should be entirely omitted.

The use of the word "Railroad" in front of the word "Station" is superfluous, as is also the mention and definition of the word "Edifice."

HEAD STATION.—A passenger station with tracks entering in one direction only.

HEAD HOUSE.—A depot built along the ends of the tracks in a HEAD STATION.

THROUGH STATION.—A passenger station open for trains in both directions.

FREIGHT.—Any commodity received for transportation for which a bill of lading is outstanding.

PASSENGER.—A person in process of transportation.

SHOP.—A house in which the work of building or repairing is carried on.

The mention and definition of Machine and Machine Shop appear superfluous.

ROUND HOUSE.—A stable for locomotives.

TURNTABLE.—A platform revolving horizontally about its center, and used for turning and shifting locomotives and cars.

CHUTE.—A trough or tube along which things can slide, propelled by force of gravity or otherwise.

COAL CHUTE.—A building used for coaling locomotives.

The mention and definition of the word "store" does not appear necessary.

STORE HOUSE.—A depot for railroad material.

FREIGHT HOUSE.—A building used exclusively for handling freight.

IN-FREIGHT HOUSE.—A freight house into which freight is unloaded from cars.

OUT-FREIGHT HOUSE.—A freight house into which freight is deposited before loading into cars.

Mr. H. W. Parkhurst (Illinois Central):—All the matter that we have to present to the Association is contained in the printed report, which, I presume, many of the members have found time to read. This, it will be noted, has followed the line of work started last year, going into more detail in some particulars and taking up particularly the form of contract which was then recommended, and which has been discussed to a considerable extent. We have not thought it advisable to present any conclusions or make any concise statement of points for the attention of the Association, the matter being as yet in a very imperfect state, and hardly capable of being handled in that way. We were getting our reports and criticisms from various sources, principally from the officials of the legal departments of the roads with which the different members of the Committee are connected, and these are only partially presented, and there is no full discussion on the subject. We will, therefore, have to leave the matter in an incomplete state.

The President:—You have before you the printed report of the Committee on Buildings. What action shall we take in regard to it?

Mr. Walter G. Berg (Lehigh Valley):—I move that the report be received as a progress report and referred back to the Committee.

Mr. A. R. Raymer (Pittsburg & Lake Erie):—I might say on behalf of the Committee, in connection with our work on passenger stations and terminals, that it was appreciated that this is a very comprehensive subject, and the Committee thought it desirable to confine its remarks to a certain class of stations, in order to make the request for information from the different companies more or less definite. For that reason the Committee, in asking for information, asked for it bearing on stations for towns having a population from ten to fifteen thousand. In harmony with this idea, the information which is presented to you in the Bulletin was secured. You will note there are a great many replies from different roads, giving the practice followed by each as to the facilities furnished in passenger stations such as have been described. Your Committee has formulated these replies and determined some averages without making conclusions.

Mr. Berg:—I simply desire to state that, in my opinion, the Committee on Buildings, in taking up the subject of a standard agreement or recommending a contract form for buildings, has struck one of the best subjects that they could, so as to impress upon the country at large the importance of the work of the Association. Of course, a committee report can be filled up with a great deal of important matter, descriptive and in connection with practice. A standard agreement form for buildings is very important. The practice among builders or architects, as mentioned in the report, is the standard agreement adopted by the American Institute of Architects, and I think it would be well if this Association could endorse the same form for railroad buildings. The erection of railroad buildings and what might be called the general run of architectural buildings differs in the agreement on account of the difference in the supervision. We are still prone to run a building contract the same as the ordinary railroad contracts, but it is necessary

to have a different class of clauses. I presume every member has found that the regular railroad standard contract form for the ordinary grading construction operations is very difficult to apply to a building contract. There are a great many clauses that have no reference whatever, and the class of contractors and builders called upon to bid on buildings are not accustomed to such clauses and do not understand them, and it frightens them. I think, therefore, if the Committee on Buildings will, as it probably intends, during the following year, aid to present a well-digested and well-considered agreement to the convention for adoption, it would be an excellent plan, and one that will be for the benefit of the Association and the profession at large.

(The motion, that the report be received as a progress report and referred back to the Committee, was carried.)

REPORT OF COMMITTEE NO. III.—ON TIES.

To the Members of the American Railway Engineering and Maintenance of Way Association:

Acting under instructions of the Board of Direction contained in Bulletin No. 28, dated July, 1902, the Committee on Ties considered the several subjects assigned to it and submitted a report, which was printed and placed before the Association at its last annual meeting, but was not discussed for lack of time. The members were requested to submit written discussions, and those received in response thereto are now printed with the report.

The Committee does not reply to the discussion at this time, hoping it will be more general on the republication of the report.

The information asked for by Mr. W. C. Cushing as to the methods of preservation used on the ties, data as to life of service of which was given in the report, is added in the body of the report.

The records of renewals on the Southern Pacific and on the Atchison, Topeka & Santa Fe Railway are summarized, and the tabular records printed as appendices.

Appendix A, a paper by Dr. Hermann Von Schrenk, reviewing Bulletin No. 41 of the Bureau of Forestry, Department of Agriculture, is retained, although the bulletin itself has been printed since the annual meeting and copies sent to every member of the Association through the courtesy of Dr. Von Schrenk.

In Appendix E are given suggested definitions of other terms used in the tie business, which have been suggested by members of the Committee, but which have not been formally considered by the Committee, and are now offered for criticism. They will be considered by the Committee later in the light of such criticism as may be offered.

(1) DEFINITIONS OF TERMS.

Investigation of this subject shows that there are wide differences in the terms applicable to the various kinds of ties and their conditions. The definitions here given represent what the Committee believe to be the best and most general usage.

POLE TIE.—A tie made from a tree of such size that not more than one tie can be made from a section. Such a tie generally shows sap wood on two sides.

SPLIT TIE.—A tie made from a tree of such size that not more than two ties can be made from a section.

QUARTERED TIE.—A tie made from a tree of such size that not more than four ties can be made from a section.

SLAB TIE.—A tie hewn or sawn on top and bottom only.

SAP TIE.—A tie which shows more than a prescribed amount of sap wood in cross-section.

HEART TIE.—A tie which shows sap wood only on the corners and which sap wood does not measure more than one inch on lines drawn diagonally across end of tie.

STRICT HEART TIE.—A tie which shows no sap wood in cross-section.

WANE TIE.—A tie which has a bend or crook in its length.

DOTY TIE.—A tie which contains dote or dry rot.

PECKY TIE.—A tie made from a cypress tree which is affected with a fungus disease, known locally as peck. This does not necessarily affect the usefulness of the tie.

TAPPED TIE.—A tie made from a tree, the resin or turpentine of which has been extracted before felling.

SCORE MARKS.—Marks made by the ax as a guide for hewing.

WIND SHAKE.—A defect in timber caused by action of wind on the growing tree, resulting in the distortion or separation of the fibers.

TIE-PLATE.—Something interposed between the rail and the tie to prevent wear of the tie.

(2) SPECIFICATIONS OF UNTREATED TIES AND THE INSPECTION AND CLASSIFICATION THEREOF.

A large amount of data relating to the subject, including the specifications of a number of railroads in various parts of the country, was collected. Much of this was received so late in the year that we did not have time to formulate typical specifications, which would represent the judgment of the Committee; hence it was thought best to continue this subject for further consideration.

(3) STATISTICS.

Gratifying responses to requests for statistics on tie renewals and associated points have been received from many of our members. This will be published in tabular form in the Proceedings, in connection with this report. The importance of such information to the roads is not yet fully appreciated. Replies have been received in some cases to the effect that to give the information asked for would require more time and expenditure than could be devoted to it. While the information is desired by the Committee for the Association, it is needed most by the users of the ties. They are the real beneficiaries of the time and money expended—not the Association. If the railroads will accumulate and digest the data required for their own correct information, it will cost but little to give the Committee what it requests.

(4) PRESERVATIVE PROCESSES.

The data gathered for this year's report simply confirm the statements heretofore given as to the average life of treated ties in this country. The record of treated pine ties taken out of tracks of the Atchison, Topeka & Santa Fe Railway during 1901, compiled under the direction of Mr. H. U. Mudge, General Manager, show the following:

Removed in 1897 on 6 divisions, average life, 10.18 years.
Removed in 1898 on 7 divisions, average life, 10.56 years.

Removed in 1899 on 8 divisions, average life, 10.61 years.
Removed in 1900 on 9 divisions, average life, 10.78 years.
Removed in 1901 on 10 divisions, average life, 10.58 years.
Removed in 1902 on 10 divisions, average life, 10.70 years.

These ties were treated by the two-injection Wellhouse process, excepting for one-half of the years 1890 and 1892, and the years 1891, 1901 and 1902, when zinc-chloride alone was used.

Mr. Mudge says: "Special attention should be called to the fact that these figures represent only the average life of treated ties taken out on account of rot, and not the average life of all ties treated during each year." Also: "It must not be overlooked that it is the 'weak sisters' which come out first; the strong, sound ones remaining in a much longer time, under the principle of the survival of the fittest."

On the Chicago, Rock Island & Pacific Railway the returns of treated ties renewed in 1901 show an average life on that road east of the Missouri River of 10.66 years, and it is estimated at one year more west of the Missouri River. These ties were treated by the two-injection Wellhouse method up to 1895; since then by the three-injection Wellhouse.

On the Southern Pacific the records have been kept as in previous years and the information is given in tabular form in Appendix F. The data may be summarized as follows:

On the Atlantic System, total number of treated ties laid, beginning with 1887, 2,971,382. Total number removed to June 30, 1902, 641,918. All ties laid in 1887-8-9 had been removed; 17 per cent. of the 1890, 64 per cent. of the 1891, 83 per cent. of the 1892 and 90 per cent. of the 1893 ties are reported to be still in track.

On the Pacific System, total number of treated ties laid, beginning with 1894, 5,491,976. Total number removed, 251,961. Eighty-five per cent. of the ties laid in 1894, 75 per cent. of the 1895, 85 per cent. of the 1896, 94 per cent. of the 1897 and 98 per cent. of the 1898 are still in track. These ties were treated with zinc-chloride alone.

On the Pennsylvania Lines West of Pittsburg the following record is furnished by Mr. Thos. Rodd, Chief Engineer. The results of tests of ties laid in 1897-1898, etc., are not yet in such shape that they can be tabulated:

On the Duluth & Iron Range Railroad, Mr. R. Angst, the Chief

Station	Kind of Ties	Put In	No.	Removed Account of Decay.								Average Life, Years	Kind of Ballast
				1897	1898	1899	1900	1901	1902	Total	Per Cent.		
Hanna.....	Burnett'd Hem...	1892	200	1	4	6	....	39	38	88	44.	9.1	Gravel Stone
Hanna.....	Untreated W.Oak	1892	200	....	....	8	46	26	9	89	44.5	8.4	Gravel Stone
Kosciusko.	Burnett'd Tam...	1892	200	....	....	2	71	84	43	200	100.	8.8	Gravel Stone
Kosciusko.	Untreated W.Oak	1892	200	....	....	2	27	73	71	173	86.5	9.2	Gravel Stone

The above ties were treated by the two-injection Wellhouse method.

Engineer, says: "The treated ties which have been in the track since 1890 are still doing service and promise to live out the full scope of their allotted life." These ties were treated by the two-injection Wellhouse method.

On the Chicago & Eastern Illinois Railroad, the Chicago, Burlington & Quincy Railroad, the Great Northern Railway, the Missouri, Kansas & Texas Railway, as the experience dates no farther back than 1899, it is a matter for future reports. Some valuable data may soon be obtained from the ties experimentally laid last year on the Montgomery branch, Atchison, Topeka & Santa Fe Railway in Texas. None of these ties have, of course, yet come out.

While it is not improbable that some new methods may prove to have value, and while it is important that they should be tested experimentally, it is assumed that, for the present, our railroads will chiefly hold to the processes which have stood the test of time. The most successful of these are: (1) Creosoting, (2) Zinc-creosote, (3) Burnettizing, and (4) Zinc-tannin or Wellhouse process.

It seems desirable to emphasize the necessity for careful and conscientious supervision of the operation of a timber-treating plant. The value of treated timber, when exposed to the action of the elements, as with railroad ties in contact with the ground and with moisture, depends upon a number of conditions, such as the kind of wood, its treatment and its subsequent exposure, as well as upon the process which may have been adopted. Most important of all is the thoroughness with which the work is done. Although the processes are apparently simple, experience has shown that there are quite a number of precautions which must be observed in order to produce good work.

(1) SEASON TIES UNTIL FIT FOR TREATMENT.

This is universally done in Europe. In the United States there is divergence of opinion; the Southern Pacific Company claiming that ties of Oregon fir are best impregnated fresh cut. This may be the result of resin and slimy sap in the wood, which does not resist the entrance of the chemicals when limpid, but dries in the pores and gums the outer surfaces. In Germany the difficulty is met by sawing off thin slabs from each end of telegraph poles which have been seasoned before treating them, as the impregnating fluid chiefly enters at the ends, and not from the side surfaces.

The readiest way of governing the seasoning required for American woods will be to establish by experiment their weight per cubic foot when in condition to be impregnated throughout; which may be ascertained by chemical analysis of borings from the center, quarters and ends of treated ties, allowed to season for varying times before treatment. Room must be made in the wood for the solution, either by the natural seasoning or by extracting the sap. It is claimed by some authorities that more sap in actual bulk can be extracted from a half-seasoned tie than from one fresh from the saw, although the latter contains a greater quantity. On the Chicago & Eastern Illinois Railroad ties are treated in the order of their cutting, so that all shall get the same amount of seasoning.

All parties, therefore, in charge of tie treating plants should give particular attention to the condition of the wood at the time it goes into the retort.* In this connection some of our railroads have recently experimented as to seasoning and a descriptive note from Dr. Hermann Von Schrenk, given in Appendix A, will prove of great interest and value.

(2) DO NOT MIX TIES OF DIFFERENT SEASONINGS.

This is obvious enough, and yet is frequently disregarded. It is clear that when ties of different degrees of seasoning are treated in one retort, some will absorb more than others, and the treatment will not be uniform.

(3) TEST THE CHEMICALS FOR PURITY, ETC.

This is much more carefully attended to in Europe than in this country. Each plant has a chemist. The German specifications for testing chemicals and solutions are herewith given in Appendix B. They are reprinted from a paper to the American Society of Civil Engineers, upon "The Preservation of Railway Ties in Europe," by Mr. O. Chanute.

(4) INJECT LIBERAL QUANTITIES OF CHEMICALS.

It is assumed that for the present the chief processes used in the United States will involve the injection of chloride of zinc. The present German practice is to inject the equivalent of half a pound of the *dry salt* of chloride of zinc per cubic foot of wood. This was arrived at after some disappointing experiences with lesser amounts, and it seems well to follow this practice.

(5) VARY THE STRENGTH OF SOLUTION TO PRODUCE ABOVE RESULTS.

Ties being generally cut in winter become better seasoned in the late summer and autumn. The strength of the solution should then be reduced so as to inject the same equivalent of *dry* chloride as before. Indeed, if the amount determined on is injected, the weaker the solution, the better; for the antiseptic is more thoroughly distributed in the wood. This fact has sometimes led to the erroneous inference that weak solutions were more effective *because* they were feeble, whereas it was the uniform dissemination which produced the results.

(6) WEIGH THE BUGGY LOADS IN AND OUT. TREAT AGAIN IF DEFICIENT.

The universal practice in Germany is to weigh each buggy load (32 ties) before running it into the retort, and to weigh it again afterward. Thus is ascertained exactly how much solution has been injected into each batch. This practice has been adopted at Mt. Vernon, Ill., and found to be a very complete check upon the computations made by gauging the tanks to ascertain the total amount absorbed, the latter applying only to the whole retort charge, say 600 ties. At first a few buggy loads were

* In France beech is seasoned to weigh 45.5 to 46.7 pounds per cubic foot and European oak to 52 pounds per cubic foot. In Germany oak is seasoned to 50 pounds, beech to 45.1 and pine to 39.2 pounds per cubic foot before treatment.

found not to have absorbed enough, and they were accordingly treated a second time, but the experience thus obtained led to such sorting of ties and varying of strength of solution daily that great regularity ensued. So far as we know this practice has not been adopted at any other plant in this country.

(7) REQUIRE DAILY REPORTS OF RUNS. ALSO YEARLY STATEMENTS.

In Germany and France automatic gages, with clock attachments, record the vacuums, the pressures and the time occupied by each. The diagrams so obtained are daily given to the party for whom the work is done. General statements are also required at the end of each season's operations, showing the amounts of chemicals on hand at the beginning, the amounts purchased, and the amounts left on hand at the end. This serves as a check on the amounts injected. These may by some be considered redundant refinements, and be omitted here, but daily reports of each run are also made in Germany and some of the American works follow this practice. As one instance we give in Appendix C the form of daily report kept at Mt. Vernon, Ill. It requires about 15 minutes to fill it out.

(8) DRY THE TIES BEFORE LAYING IN THE TRACK.

This applies chiefly to the Wellhouse process, the leatheroids requiring setting and hardening before they act as seals to the outer sap cells. Drying is also necessary in plain Burnettizing. From ten to thirty days are sufficient, and may be obtained during transit or at the point of delivery for use.

(9) USE DATING NAILS AND KEEP RECORD OF TIE RENEWALS.

Special attention was called to this last recommendation by a circular, November 12, 1902, issued by Mr. Geo. W. Kittredge, Past-President of this Association. It is herewith reprinted as Appendix D. It is hoped that the importance of Mr. Kittredge's last recommendation, that "the value of an accurate record of the life of ties can not be overestimated," will be appreciated and acted on. Material improvements have been made in the treating methods at many American plants, and more will doubtless be made as experience increases. Full records will show how these will affect the average life of the ties when laid in the track. Similar improvements have taken place in Europe. Some works were found to accomplish much better results than others, and the treating of ties has become a specialty carried on by experts.

Various methods of marking ties by systems of notching have been suggested, but after careful investigation the Committee believes that such system is of questionable value. The Southern Pacific, the Santa Fe System and perhaps others indent on the ends of ties figures indicating month and year of treatment. This is done by use of a hammer, on the face of which the figures are cut, different ones for each month being necessary. This method is reported to be fairly satisfactory, though the figures are sometimes blurred by trackmen in knocking ties to line in the track.

SUPPLEMENTARY REPORT OF COMMITTEE NO. III. —ON TIES.

To the Members of the American Railway Engineering and Maintenance of Way Association:

The Committee on Ties submits its report for the year 1903, supplementing its report to the fourth annual convention of the Association and Bulletin No. 43, neither of which have been read and discussed in annual convention.

The Committee has held three meetings during the past year and considered the subjects assigned to it by the Board of Direction. These were "Specifications of Untreated Ties and Classification and Inspection of New Ties. Preservative Processes. Statistics." A proposed Specification for Ties is herewith submitted. When this matter was first taken up, it was the opinion of some members of the Committee that several specifications should be prepared, adapted to the various geographical divisions of the country. When more carefully considered, however, this was found to be inexpedient. The railroads of New England and New York are to-day purchasing many of their ties in the Southern States; Minnesota and Wisconsin roads buy oak in Arkansas, and an attempt to prepare local specifications would fail because of the general market. Consequently, the Committee submits a general specification covering those points common to all ties and so arranged that any road desiring to make use of it, if adopted by the Association, can make it accord with their special requirements by eliminating features which will not suit their local conditions.

The timber adapted for use as ties has been divided into two classes: those which make a durable tie in their natural condition, and those which require some preservative treatment to prevent early decay.

With respect to dimensions, ties have been divided into classes, the letter indicating the cross-section, and the numeral the length. An examination of a large number of specifications shows a variation in width of ties from 6 to 10 in., and in thickness from 6 to 7 in. The lengths are either 8, 8½ or 9 ft. A table of dimensions is given in the specifications covering all probable combinations in sizes. A 6x8 in. x8 ft. tie would be referred to as an E 8 tie.

If purchasers of ties using this specification are willing to accept a certain number of a slightly smaller size than that desired, it is expected that they will specify the number of such ties of another letter which will be accepted and specify the price therefor. This price should be in some actual proportion to the relative values of the ties. No provision has been made for what are commonly called culls. The purchaser can find sizes in the table sufficiently small to cover any tie large enough for use, and an unsound tie ought not to be received at any price.

The provision is made that ties for inspection shall be piled in groups of 25 or 50, to facilitate estimating from trains the quantity of ties on hand by the Roadmaster or Superintendent.

SPECIFICATIONS.

The following woods may be used for tie timber without any preservative treatment:

White Oak family.
Long-leaf strict heart yellow pine.
Cypress.
Redwood.
White Cedar.
Chestnut.
Catalpa.
Locust.
Walnut.

*The following woods shall not be used for tie timber without a preservative treatment approved by the purchaser:

Red Oak family.
Beech.
Elm.
Maple.
Gum.
Loblolly—short leaf, lodgepole, Western yellow pine, Norway, North Carolina pine and other sap pines.
Red Fir.
Spruce.
Hemlock.
Tamarack.

.*All ties must be well and smoothly hewed or sawed out of sound straight timber, sawed ends, and must be of specified dimensions, with straight and parallel faces, the minimum width of either face to be not less than that given in the table of dimensions. All ties must have bark entirely removed. Ties shall be free from splits, shakes, loose or decayed knots or any other imperfections which may impair their strength or durability.

DIMENSIONS.

*Except in pole ties, none shall be less than 8-in. face, and in no tie shall the thickness be less than 6 in. A variation in size will be permitted of one-half in. over in thickness, 2 in. over in width and 1 in. over in length.

*In pole ties the face may be less than that given in the tables of dimensions below, but the least area of cross-section shall be not less than the area corresponding to the tabular dimensions, and in no case shall the face be less than 6 in.

*See amendments, page 78.

TABLE OF DIMENSIONS.

Class.	*Thickness by Width.	Length.		
	Inches.	Feet.	Feet.	Feet.
A	7 x 10	8	8½	9
B	7 x 9	8	8½	9
C	7 x 8	8	8½	9
D	6 x 9	8	8½	9
E	6 x 8	8	8½	9
F	6 x 7	8	8½	9
G	6 x 6	8	8½	9

*Ties must be piled on the right of way of the railroad at station yards or at points between stations designated in the contract, not less than 10 ft. from the nearest rail; each pile to be of either 25 or 50 ties, built with two ties on the ground and above in alternate courses of 7 and 2, except the tops, which shall be placed to form a water shed, as shown in cut. Each pile must be plainly marked with the owner's name. Three feet of space must be left between piles to allow easy inspection. Sawed ties must be piled separately from hewed ties.

Ties shall be cut, as far as possible, in the winter period; that is, from October to March.

DEFINITIONS.

The definitions of terms as given on pages 4 and 17 of Bulletin 43 have been reconsidered, some omitted as unnecessary and others modified. They are reprinted as corrected herewith.

POLE TIE.—A tie made from a tree of such size that not more than one tie can be made from a section. Such a tie generally shows sap wood on two sides.

*SPLIT TIE.—A tie made from a tree of such size that two or more ties can be made from a section.

*QUARTERED TIE.—A tie made from a tree of such size that only four ties can be made from a section.

SLABBED TIE.—A tie sawn on top and bottom only.

SAP TIE.—A tie which shows more than a prescribed amount of sap wood in cross-section.

*See amendments, page 78.

*Heart Tie.—A tie which shows sapwood only on the corners, and which sap wood does not measure more than one inch on lines drawn diagonally across end of tie.

*Strict Heart Tie.—A tie which shows no sapwood in cross-section.

Wane Tie.—A squared tie showing part of the original surface of the tree on one or more corners.

*Doty Tie.—A tie which contains dote or dry rot.

*Pecky Tie.—A tie made from a cypress tree which is affected with a fungous disease, known locally as peck. (This does not necessarily affect the usefulness of the tie.)

Tapped Tie.—A tie made from a tree the resin or turpentine of which has been extracted before felling.

Score Marks.—Marks made by the ax as a guide for hewing.

*Shakes.—A separation of the wood fibers, due to the action of the wind.

Checks.—Small cracks in the wood due to seasoning.

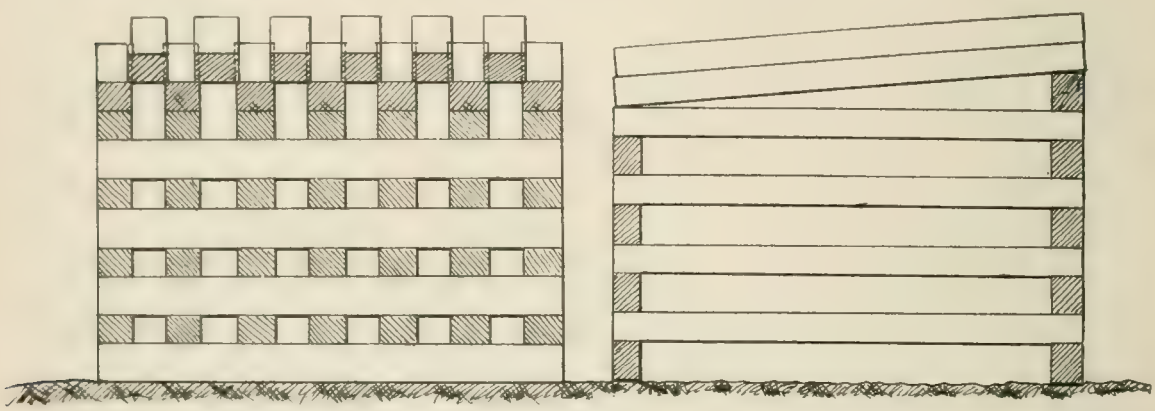

Fig. 1.—Piling Diagram for Fifty Ties.

Tie-Plate.—Something interposed between the rail and the tie to prevent wear of the tie.

STATISTICS.

It has not been considered desirable to ask the roads for new tabular statements in accordance with the forms already adopted by the Association. It is to be hoped the desirability of keeping such records, for their own benefit, will be recognized by our members, and perhaps next year, or at least at an early date, it will be possible to secure reports from such a number and in such a complete state as will permit valuable conclusions to be deduced therefrom.

PRESERVATIVE PROCESSES.

There is not a great deal to add to the report as given in Bulletin 43, issued in September, 1903. By referring to it, the latest information from the Atchison, Topeka & Santa Fe Railway and of the Southern Pacific Lines, as regards the results secured from their use of large numbers of treated ties for extended periods, will be found. The comparative results of treated and untreated ties, laid together at two points of the

*See amendments, page 78.

Pennsylvania Lines West of Pittsburg, as given in Bulletin 43, cannot be extended in full for the past year, on account of the absence of data covering the untreated oaks laid at the same time. The last of the treated tamarack ties were removed in 1902 as already reported. Of the treated hemlocks, 35 were removed in 1903, making 123 removed out of the 200 placed in track in 1892; the average life of those so far removed being 9.65 years for the hemlocks in rock ballast, and 8.8 years for the tamaracks in gravel ballast.*

The list of treating plants in the United States is reprinted herewith, with corrections intended to bring it up to date. The last column, giving the estimated capacity in ties per annum, is retained, although it is recognized as being to some extent inconsistent. It would probably be better to omit this item and add a statement of the number and size of the cylinders in each.

Inquiries have been made of the various treating plants in this country to determine the number of ties treated during the year 1903 in the United States. Several large works were completed during 1903, not getting in operation early enough to turn out their full capacity during that year. The reports received from all but one of the above works say

TIMBER PRESERVING PLANTS IN THE UNITED STATES.

Location	Year Built	Owner	Process	Kind of Wood	No. Retorts	Estimated Capacity Ties per An.
Portsmouth, N. H.	.....	Otis Allen & Co...	Kyanizing....	Spruce....	4	150,000
Lowell, Mass.....	1848	" " ...	Kyanizing ...	Spruce....	2	
Las Vegas, N. M ..	1885	A. T. & S. F. R. R.	Burnettizing.	Pine.....	3	500,000
Bellemont, Ariz...	1898	A. T. & S. F. R. R.	Burnettizing.	Pine	2	350,000
Chicago, Ill.	1886	Chi. Tie Pre. Co...	Zinc-tannin ..	Hemlock .	4	500,000
Mt. Vernon, Ill ...	1899	Chi. Tie Pre. Co...	Zinc-tannin ..	Black Oak	1	200,000
Somerville, Tex...	1897	Tex. Tie & L. Co..	Various.....	Pine, etc..	6	2,500,000
Kalispell, Mont....	1901	Gt. Northern Ry...	Zinc-tannin ..	Pine Fir..	4	1,200,000
Houston, Tex	1891	So. Pacific Co.....	Burnettizing.	Pine.....	5	1,500,000
Oakland, Cal	1889	So. Pacific Co.....	Creosoting ...	Pine, etc..	2	1,000,000
Cal. & Oregon.....	1894	So. Pacific Co.....	Burnettizing.	Pine Fir..	2	1,000,000
Beaumont, Tex ..	1897	Int.Creo.& Con.Co.	Various	Pine, etc..	1	500,000
Sheridan, Wyo	1899	C. B. & Q. Ry.....	Burnettizing.	Pine, etc..	2	700,000
Greenville, Tex ...	1901	Mo.Kan.& Tex.Ry.	Zinc-tannin ..	Pine Gum	3	900,000
Alamogordo, N. M.	1902	Ala. Lumber Co...	Zinc-tannin ..	Pine, etc..	2	600,000
Portable Plant	1902	Union Pac. Ry.....	Burnettizing.	Pine, etc..	2	600,000
Portable Plant	1902	Oregon Short Line	Burnettizing.	Pine, etc..	2	600,000
Carbondale, Ill....	1902	Ayer-Lord Tie Co.	Various	Red Oak..	7	3,500,000
Grenada, Miss.....	1903	Ayer-Lord Tie Co.	Various	Pine, etc..	2	800,000
Long Island City .	1878	Eppinger & Russell	Creosoting ...	Pine, etc..	4	800,000
Perth Amboy, N.J.	1890	U. S. Wood Pre. Co.	Creo. Resin ..	Pine, etc..	4	1,200,000
Norfolk, Va.....	1896	Norfolk Creo. Co..	Creosoting ...	Pine, etc..	4	900,000
W. Pascagoula, La.	1876	L. & N. R. R.....	Creosoting ...	Pine, etc..	2	400,000
New Orleans, La..	1902	Am. Creos. Co.....	Creosoting ...	Pine, etc..	2	400,000
Norfolk, Va.....	.....	At.Creo.& W.P.Wk	Creosoting ...	Pine, etc..	3	600,000
Slidell, La.....	.....	So. Creos. Co.....	Creosoting ...	Pine, etc..	.....	.....
Seattle, Wash.	.....	Colman Creos. Co.	Creosoting ...	Pine, etc..	1	300,000
Everett, Wash.....	.....	Puget So. T. P. Co.	Creosoting ...	Pine Fir..	2	600,000
Escanaba, Mich...	1903	C. & N.-W. R. R...	.....	.....	3	900,000
Texarkana, Tex...	1902	Int.Creo.& Con.Co.	Various	Pine.....	2	600,000
Texarkana, Tex...	1902	So. Tie & T. T. Co.	Burnettizing.	Pine.....	1	300,000
New Orleans, La..	.....	N.O.Wood Pres.Co.	Various	Pine.....	1	300,000
Portsmouth, Va...	1881	Wyckoff P.& C.Co.	Creosoting ...	.....	.....	.....

*Mr. R. Trimble, Chief Engineer Maintenance of Way, N. W. Sys., Pennsylvania Lines, calls attention to the fact that the average life of the Burnettized hemlock, figuring those remaining in track as good for at least until the date of the next inspection, is 10.58 years. The Committee's figured life is for those that have been *removed.*

that 11,254,729 ties were treated during 1903. When this is compared with the statement that five years ago there had probably not been ten million ties treated in this country, including all years, the growth can certainly be considered remarkable and exceedingly encouraging to those interested in the preservation of our forests and of our tie-wood supplies.

Attention has been called to a method developed abroad, whereby the wear under the rail or at the spike in a soft wood tie can be materially decreased. This consists in the insertion of a hardwood trenail, so-called, being a wood screw of two or three inches diameter, having a spike hole bored in the center. This trenail is screwed into a hole tapped in the tie, and a spike driven or screwed into it. This method has been followed for the past six years in France, with very satisfactory results, the trenails being applied either to new ties or to old ones which had begun to make trouble through failure to hold the spike. It is understood several of the railroads in the United States have agreed to test these trenails, and it is hoped some valuable results may be derived therefrom.

Below is given a statement of a test of the comparative merits of cypress ties from three different localities, plain heart pine ties and pine ties treated with zinc-creosote. They were laid in the main line of the Southern Pacific, near Watkins, in Western Texas, in April, 1894. The

STATEMENT OF TEST TIES LAID IN THE WATKINS SHORT LINE IN APRIL, 1894. EXAMINED DECEMBER 10, 1903. PERIOD OF TRIAL NINE YEARS EIGHT MONTHS.

Kind of Ties.	No. Placed.	Removed.	Per Cent.
Teche Cypress	850	10	1.2
Mermentau Cypress	117	5	4.
Calcasieu Sawed Cypress	1,676	126	7.5
Zinc-Creosote	1,824	143	8.
Plain Heart Pine	1,694	1,593	94.

record of the times at which part of these were removed is not available, but at the date of the last examination, after a period of nine years and eight months, the percentages which had been removed are as given in the table.

The cypress is what is known as red cypress, and differ from each other only in the particular district from which they come.

The zinc-creosoted ties were of sap pine, and were treated, first, with an injection of 12 pounds of 2 per cent. solution of zinc-chloride. This was followed by a second injection of 3 pounds of creosote, both quantities being given in pounds per cubic foot. It is understood the ties were allowed to dry out for 10 days between the two treatments.

In connection with the above table, it might be well to call attention to the fact that, after nine years and eight months, only 6 per cent. of the heart pine ties remained in the track. By referring to page 22 of Bulletin No. 43, it will be seen that the percentage of burnettized sap pine ties remaining in the track of the Southern Pacific lines in the same territory as the above experimental ties, after ten years, was 83 per cent.

During the past year there have been several new processes for the preservation of wood called to the attention of the Committee, among which may be mentioned the so-called "Rüping process," by which it is claimed to be possible to thoroughly impregnate the cell walls of timber without at the same time filling the cell spaces, resulting in a large economy in the amount of creosote used. If the claims made are correct, this process would seem to offer great promise for the treatment of ties, as thereby the cost of creosoting would be reduced to but little more than the present cost of treating with zinc-chloride. In all probability, the amount of creosote so retained in the tie would be sufficient to furnish protection against decay for a number of years.

Another proposed method of treatment is the so-called Ferrell process, which is a modification of the Boucherie process. The ties are handled individually into small cylinders adapted for one only, and are there subjected to heavy hydraulic pressure applied at one end of the tie, to force the preservative solution longitudinally through it. The chemicals proposed for use are sulphate of iron and sulphate of alumina. This process naturally divides itself into two parts, one the method of injection, the other the chemicals to be used. It is claimed that by the method of injection followed, the cost of plant and cost of treatment are very materially reduced as compared with works adapted to treat by the ordinary methods, and that the distribution of the preservative is much more uniform throughout the stick than is secured by the usual methods. The Committee has no evidence to substantiate either claim. As to the chemicals proposed for use, it is claimed that they are more stable and much cheaper than zinc-chloride. The value, however, of any chemicals to be used for this purpose must be determined, not by laboratory experiments or theoretical considerations, but by the actual test of time with ties in track under natural conditions.

It is suggested that, with the increasing scarcity of timber, it may be possible to use tie forms, which will insure greater economy in getting ties, and therefore insure a larger supply. Where softer woods are made into ties, they are now generally treated chemically, which permits the use of sap wood. Such ties are also frequently provided with tie-plates. Where tie-plates are used, it is possible to use a tie with a smaller bearing surface. The United States Bureau of Forestry has suggested the use of a tie of the following dimensions:

Half-round tie: Upper bearing surface, min., 6 in.; thickness, 7 in.; lower bearing surface, 10 in.; length, 8 to 8½ ft.

CONCLUSIONS.

Your Committee recommends that the Association adopt the definitions of terms as given in the supplementary report.

Your Committee also recommends that the proposed standard specifications for cross-ties be adopted.

Respectfully submitted,

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W. W. Curtis, *Vice-Chairman;* Consulting Engineer, Chicago, Ill.
W. Archer, Prin. Asst. Eng., B. & O. S. W. R. R., Cincinnati, O.

ROBERT BELL, Superintendent, Pennsylvania Railroad, Buffalo, N. Y.
E. FORD, Superintendent, V. S. & P. Ry., Vicksburg, Miss.
R. R. HAMMOND, Gen. Man., Chicago & Eastern Illinois R. R., Chicago.
E. E. HART, Engineer, N. Y., C. & St. L. Ry., Cleveland, O.
W. W. HAYDEN, Chief Engineer, M., J. & K. C. Ry., Mobile, Ala.
P. A. MCCARTHY, Consulting Engineer, Lufkin, Texas.
J. C. NELSON, Roadmaster, A. G. S. Ry., Birmingham, Ala.
S. M. ROWE, Consulting Engineer, Chicago, Ill.

Committee.

AMENDMENTS.

SPLIT TIE.—A tie made by splitting from a tree of such size that two or more ties can be made from a section.

QUARTERED TIE.—A tie made from a tree of such size that four ties only are made from a section.

HEART TIE.—A tie which shows sapwood on the corners only, which does not measure more than one inch on lines drawn diagonally across the end of tie.

STRICT HEART TIE.—A tie having no sapwood.

DOTY TIE.—A tie which contains dote.

PECKY TIE.—A tie made from a cypress tree which is affected with a fungous disease, known locally as peck.

SHAKES.—A separation of the wood fiber, due to the action of the wind.

SLAB TIE.—A tie made from slabs.

SAWED TIE.—A tie sawed on all four sides.

HALF TIE.—A tie made from a tree of such size that two ties only can be made from a section.

SPECIFICATIONS.—The following woods shall preferably not be used for tie timber without a preservative treatment, etc.

All ties must be well and smoothly hewed or sawed out of straight growing timber of specified dimensions and out of wind, sawed ends, with straight and parallel faces, the minimum width of either face to be not less than that given in the table of dimensions. All ties must have bark entirely removed before being delivered on the company's ground.

DIMENSIONS.—Except in pole ties with rounded sides, none shall be less than 8-in. face, and in no tie shall the thickness be less than 6 in. A variation in size will be permitted of one-half in. over in thickness, 2 in. over in width and 1 in. over in length.

In pole ties with rounded face the face may be less than that given in the table of dimensions below, but the least area of cross-section shall be not less than the area corresponding to the tabular dimensions, and in no case shall the face be less than 6 in.

The heading in column 2 of Table of Dimensions to read: "Thickness by Face," instead of "Thickness by Width."

Ties which are to be delivered along the right of way of the railroad must be piled at station yards or at points between stations designated in the contract, not less than 10 ft. from the nearest rail; each pile to be of either 25 or 50 ties, built with two ties on the ground and above in alternate courses of 7 and 2, except the tops, which shall be placed to form a watershed, as shown in cut. Each pile must be plainly marked with the owner's name. Three feet of space must be left between piles to allow easy inspection. All rejected ties must be removed from the company's right of way within ten days after notice is given.

APPENDIX.

(A) SEASONING TESTS.

By Dr. Hermann Von Schrenk.

The length of life of a tie is influenced considerably by the amount of water contained in the timber when it is laid in the track. Wet timber will decay almost twice as fast as the same timber dried. The present practice of laying ties in the track, immediately or very soon after they are cut from the wood is an extremely wasteful one. Moreover, the method of piling, in general use, when ties are kept for any length of time, is of such a character as to prevent the rapid evaporation of water from the green timber. The reason why improved methods of piling have not been in general use is probably because of the belief that in order to obtain seasoned timber, a very long period of time was necessary to get this seasoned wood. During the past year extensive tests were undertaken by the Bureau of Plant Industry, United States Department of Agriculture, to determine the rate of evaporation from freshly cut ties. The tests were made chiefly with an inferior grade of timber, "lodgepole pine," which had hitherto not been used extensively for tie purposes. In making these tests the following points were kept in mind: First, to determine the moisture contents of the wood cut during the various months of the year. Second, to determine the rate of evaporation from various forms of piles. Third, whether properly seasoned wood of an inferior grade could be made equal to similar wood of a higher grade. Fourth, to determine the relation of properly seasoned wood to the various impregnating methods now in use.

The tests were started in May, 1902. Freshly cut ties of the lodgepole pine were piled in three forms of pile: First, a close pile, 9x9 (9 ties each way); second, a partially open pile, 7x7 (7 ties each way), and third, an open crib pile, 7x2 (7 ties one way, 2 ties the other). These ties were weighed twice a month until they had reached an approximately constant weight. As the tests are still in progress, simply one of the tables is appended to show the results so far obtained. The two tables which follow give the weights and loss per cent. of ties cut in June. It will be noted whereas in one case it took 60 days to reach a loss of weight of 30 per cent., in the other case it took but one-third of that time.

1902. SEASONING TESTS ON TIES AT BOZEMAN.

"Lodgepole pine." Piled in solid pile. June cutting. Hewn.

Date.	No. of ties.	Weight per tie.	Loss in pounds.	Loss per cent.
June 10th	50	152.75	.....	.....
June 15th	50	149.13	3.62	2.53
June 30th	50	130.93	21.82	14.26
July 15th	50	114.77	37.98	24.86
August 15th	50	104.24	48.51	31.75
September 10th	50	101.33	51.42	33.66

Crib "A," Piled 7x2. Open east and west. Hewn.

Date.	No. of ties.	Weight per tie.	Loss in pounds.	Loss per cent.
June 10th	50	155.39	.....	.....
June 15th	50	137.36	18.03	12.08
June 30th	50	108.06	47.33	30.45
July 15th	50	99.30	56.09	36.09
August 15th	50	95.21	59.68	38.46
September 10th	50	93.44	61.95	39.86

It will appear from these figures that an approximately air dry condition of the lodgepole pine was reached after seasoning these ties for three months. The cost of piling the ties in the best possible way, viz., in the open crib, 7x2 pile, when the ties were unloaded from cars into a yard, was found to be practically equal to the cost of piling in the usual close form. In other words, the additional cost for piling according to the improved plan was insignificant.

The advantages gained by reducing the weight in water were: First, the saving in freight; second, the greater ease with which such ties can be impregnated, and, third, the greater length of life which can be obtained from such ties because of the greater thoroughness with which they can be treated. Tests were furthermore made with ties treated with the zinc-chloride process, and it was found that the rate of loss was about as follows:

Treated ties, Sheridan, piled 7x2:

Date.	No. of ties.	Weight.	Weight per tie.	Loss per tie in pounds.	Per cent. loss.
June 8th	60	10,326	172.10	.....	.....
July 11th	60	7,368	122.80	49.30	28.64
July 25th	60	6,916	115.27	56.83	33.02
August 11th	60	6,582	109.70	62.40	36.25
August 25th	60	6,408	106.80	65.30	37.94
September 25th	60	6,258	104.30	67.80	39.40
October 25th	60	6,172	102.86	69.24	40.23

Treated ties, Sheridan, piled in triangular form:

Date.	No. of ties.	Weight.	Weight per tie.	Loss per tie in pounds.	Per cent. loss.
June 17th	33	5,476	165.94	.....	.....
July 11th	33	3,920	118.66	47.28	28.49
July 25th	33	3,687	111.73	54.21	32.67
August 11th	33	3,516	106.54	59.40	35.85
August 25th	33	3,418	103.58	62.36	37.58
September 25th	33	3,377	102.33	63.61	38.33
October 25th	33	3,301	100.03	65.91	39.66

OAK TESTS.

Similar seasoning tests were begun two months ago with oak timber to determine their rate of seasoning. Some preliminary results were as follows:

Untreated oak ties; white oak; piled 7x2; hewn:

Date.	No. of ties.	Weight per tie.	Loss per tie in pounds.	Loss per cent.
August 7th	75	165.67	.....	.....
October 27th	75	146.28	19.39	11.70

The tests with the lodgepole pine and the oak are to be continued for this year (1902), and perhaps longer, and similar tests will be begun during the coming months with the southern and western pines, and a number of the eastern timbers.

A full account of these tests, with photographs of the shape of the piles, was published in Bulletin No. 41 of the Bureau of Forestry, United States Department of Agriculture.

(B) TESTING OF IMPREGNATING SOLUTIONS FOR IMPERIAL PRUSSIAN RAILWAYS.

For the impregnation of timber there are at present two products in use: First, chloride of zinc; second, tar-oil.

TESTING OF CHLORIDE OF ZINC.

The chloride of zinc for impregnating purposes will be manufactured as a concentrated solution, containing about 50 per cent. of anhydrous chloride of zinc. It is best to use such a strong solution for testing, and for that purpose, samples are to be taken directly from the shipping tank or carboy.

The zinc-chloride solution used must be as free from impurities as possible, particularly from iron and free acid. Therefore, it is to be determined whether or not iron and acid are present.

TEST FOR FREE ACID.

Twenty grammes (by weight) of the above strong zinc-chloride solution are to be mixed with distilled water; the whole to amount to 100 c. c. (by measure), the mixture to be well shaken.

(a) There is no free acid present if the mixture, by shaking, becomes cloudy, and, particularly if after a short period of rest, flakes settle down, which will again dissolve to a clear fluid, upon the addition of a few drops of muriatic acid (HCl). No further test is then required.

(b) If, after shaking, the mixture remains clear, then an excess of acid is present, the amount of which can be determined by the following manipulation:

Take several reagent bottles and put in each 10 c. c. of the above-described mixture, then add to each bottle a measured successively increasing quantity of a solution of one-tenth normal soda. For example: Add to the first reagent bottle 0.1 c. c., to the second 0.2 c. c., to the third 0.4 c. c., and so on. Shake well and observe in which bottle a remaining white flaky precipitation will settle. The proportion of soda which lies between the mixture where a precipitation is produced, and that where no precipitation

is produced, exactly represents the quantity of free acid present in the solution. For example, the mixture in the bottle to which 0.2 c. c. of the soda solution was added, remains clear, while in the following reagent bottle, where 0.4 c. c. soda solution was added, a precipitation is produced; then, 0.3 c. c. soda solution is exactly the quantity corresponding to the free acid present in the chloride of zinc solution.

Should there be required for this test more than 0.4 c. c. of the one-tenth normal soda solution, then the percentage of free acid is too high in the chloride of zinc solution, and such solution must not be used for impregnation.

TESTING FOR IRON.

Take 10 c. c. from the above-described mixture of zinc-chloride solution and distilled water, and add a few drops of concentrated nitric acid (HNO_3) and shake well. Divide this mixture into two equal parts. To one part, without diluting, add a quantity of ammonia (NH_4OH) and shake well. If this mixture remains clear, no iron is present. Through the presence of iron in the mixture, more or less brown flakes will precipitate, corresponding to the amount of iron present. Should there precipitate in the mixture a quantity of gray-white (not brown) flakes, then not only iron, but also another impurity (nearly always magnesia) is present. In this latter case a more complete test has to be made, and, therefore, the zinc-chloride solution must be sent to a chemist. But this case will happen very seldom.

The second part of the mixture of 10 c. c. to which nitric acid was added, should be diluted with distilled water, and 5 c. c. of a solution of 10 per cent. yellow prussiate of potash added, the whole to be well shaken. A very ample precipitation will be produced, which will look snow-white, or very light yellowish, if the zinc-chloride solution is free from iron; but in the presence of iron it will look more or less blue, according to the amount of iron. If the precipitation shows a corn flower blue color, then the zinc-chloride solution surely contains a high percentage of iron and must therefore be rejected.

To avoid, in testing, the weighing of the 20 grammes of the strong solution, the use is recommended of the easier method of measuring. First find the specific gravity, at 15 degrees Celsius, of the strong concentrated zinc-chloride solution. The quotient of this specific gravity into 20 grammes shows the number of cubic centimeters which must be measured off and which represent exactly 20 grammes by weight. For instance, the specific gravity of the strong zinc-chloride solution is 1.6, then 1.6 divided into 20 grammes gives the number of cubic centimeters $\left(\frac{20}{1.6} = 12.5 \text{ c. c.}\right)$ which have to be measured off to be used for testing as described before.

TESTING OF TAR-OIL.

At a temperature of 20 degrees Celsius the tar-oil must be limpid, and to test it, shake the tar-oil well, pour a few drops on a folded filter paper, and observe whether after absorption there remain undissolved particles on

top of the paper. If the amount of these is large, the tar-oil must not be used for impregnation. To find the specific gravity, the tar-oil must be heated, or cooled off, to a temperature of 15 degrees Celsius; then drop slowly a hydrometer into the same, and read the number at the surface of the oil. This number indicates the specific gravity of the tar-oil at 15 degrees Celsius; small variations in temperature are of minor importance, and can be corrected closely enough by adding or subtracting 3 to the figure in the third place of the specific gravity for every 2 degrees variation from 15 degrees Celsius.

LABORATORY DISTILLATION OF THE TAR-OIL.

By means of a funnel, 102 c. c. of tar-oil at about 15 degrees Celsius are to be filled into a retort, a thermometer is to be inserted, but in such a manner that the quicksilver ball shall be in or below the neck of the retort but shall not touch the oil, or will not be covered by the same. The retort must be heated slowly, until all the water, which is contained in nearly every tar-oil, is evaporated. Stronger heat can then be applied to the retort, but it must be so regulated that in one second two drops will distill over. The distilled product will be caught in a graduated glass cylinder, and the different quantities are to be read and noted which distill over from the oil (become volatile), within the various intervals of temperature, say to 125 degrees Celsius (150 degrees) from 150 to 235 degrees, and again from 150 to 355 degrees Celsius, and which are specified in the "Description of the Process, and Specifications" as to the composition and proportions of the impregnating fluid.

FINDING THE PERCENTAGE OF CARBOLIC ACID.

(Acid Constituents of the Oil.)

The entire amount of the distilled tar-oil is to be mixed in a separating funnel with 50 c. c. of caustic soda of 1.15 specific gravity at 15 degrees Celsius, shaken well for about five minutes, after which let it stand and settle. The caustic soda absorbs the carbolic acid and precipitates; the stopcock of the funnel is to be opened and the precipitated caustic soda is caught in a 200 c. c. graduated glass cylinder. The same operation must also be repeated with 50 c. c. of fresh caustic soda, to make sure that all carbolic acid is extracted from the oil. The caustic soda of both manipulations is then to be combined, about two tablespoonfuls of salt (NaCl) added and this dissolved by means of stirring; the required quantity of concentrated muriatic acid (HCl) added, and the combination again stirred up until well mixed. After cooling off the hot mixture, read the quantity of the separated carbolic acid in percentage of cubic centimeters, and add to this number ½ per cent. for the small amount of carbolic acid still remaining in the acid solution.

All the figures obtained are to be compared with those specified in the description of the composition and proportions of the impregnating fluids. Small differences should not be cause for rejection, as small variations in testing, resulting from barometric changes, can not be avoided,

and the result of the test is influenced by them. However, the figures obtained by the above-described tests are sufficiently close to judge of the quality of the impregnating fluids. It is not advisable that the tar-oil for testing be taken directly from the shipping tank, but it is better to take the samples from the receptacle of the apparatus in the impregnating plant from which the mixing vessels, or the impregnating cylinder (in the impregnation with pure oil) will be supplied.

The Chief of the Operating Inspection 3.

Berlin, June 14, 1899. (Signed.) SETTGAST.

(C) FORM OF DAILY REPORT OF TIE-TREATING PLANT AT MT. VERNON, ILL.

Run No. 147—Thursday, October 30, 1902—Day run.

Chloride of Zinc, 384.4 cu. ft. x 64.4 Sp. Gr.....=24690 lbs. absorbed
Displacement of empty cylinder.....= 3374 cu. ft.
Charge 6.15 cu. ft. x 284 sq. ft.....= 1746 cu. ft.

Hence, displaced by ties.....= 1628 cu. ft.

1628 ÷ 614 = 2.65 cu. ft. per tie.

24.690 ÷ 614 = 40.21 pounds solution absorbed per tie by measurement.

24.870 ÷ 614 = 40.50 pounds solution actually absorbed per tie by weighing.

24.870 ÷ 1628 = 15.27 pounds solution absorbed per cubic foot.

15.27 x 3.8% = 0.58026 pounds $ZnCl_2$ absorbed per cubic foot.

Actual weight before treatment, 84440 ÷ 1628 = 51.86 pounds = weight per cubic foot of wood.

15.27 ÷ 51.86 = 29.44% absorbed per weight of wood.

29.44% × 3.8% = 1.11872% dry $ZnCl_2$ absorbed by measurement.

Actually 29.45% × 3.8% = 1.11910% dry $ZnCl_2$ absorbed by weighing.

Number of ties in run = 614—Cut in February, 1902.

Strength of solution = 3.8%.

(D) USE OF DATING NAILS AND KEEPING OF TIE RECORDS.

November 12, 1902.

To the Managing Officers of American Railroads:

GENTLEMEN:—The attention of the managements of American railroads is invited to the system of marking cross-ties, advocated in the report of the Committee on Ties, submitted at the third annual convention of the American Railway Engineering and Maintenance of Way Association.

The plan proposed is similar to that adopted by the United States Department of Agriculture in a section of experimental track laid in the state of Texas, and briefly described is as follows: Each tie is marked with a dating nail; this is placed between the rails on top of the tie,

generally at a specified distance from the rail. They are of steel, covered with zinc or tin, and have the year stamped in the head. When renewals take place, the date at which each tie was laid is noted, and in this way an absolutely reliable record is obtained. The nails cost very little (about 6 cents per pound—thirty nails), and when put in by the section gang, the labor is very slight. Several American railroads have already adopted this plan, and it is to be hoped that the practice will eventually become general.

Accurate statistical information in regard to the life of treated and untreated ties, a comparison of the different kinds of wood used for cross-ties under varying conditions of soil and climate, etc., is essential to the proper study of the tie question. For the purpose of making data of this character available and presenting it from year to year, a series of blank forms has been prepared by the Committee on Ties, which have been adopted by the Association as standard, and it is suggested that each road take the necessary steps to at once inaugurate the system of keeping tie records in the manner proposed by the Committee.

The value of an accurate record of the life of ties can not be over-estimated, for it is the only way in which reliable conclusions can be drawn. It is to be hoped that all roads will appreciate the importance to themselves and to others of keeping up this information.

Samples of the blanks above referred to will be gladly furnished by the Secretary of the Association, 1562 Monadnock Block, Chicago, Ill., on application.

Respectfully,

GEO. W. KITTREDGE, *President.*

(E) ADDITIONAL DEFINITIONS OF TERMS.

The following definitions have been submitted since the Committee's report was printed and distributed. These terms are offered for criticism of the members of the Association:

HEART SHAKES.—Clefts in the center of the tie.
RING SHAKES.—Separation of some of the annual rings.
STAR SHAKES.—Splits radiating from the center.
SHAKES.—Small separation of the fiber.
CRACKS.—Large separation of the fiber.
SPLITS.—Large cracks extending several feet.
BRASHY TIES.—Ties made brittle by decay.
TWISTED TIES.—Ties with spiral grain.
CROSS-GRAIN TIES.—Ties sawn diagonally to the grain.
DEADWOOD TIES.—Ties made from dead timber.

(F) STATISTICS.

TABLE I.—LIFE RECORD OF TIES.

CINCINNATI NORTHERN RAILROAD.

Data completed to Dec. 31, 1902.

Total Number of Cross-Ties of all kinds laid in Tracks (incl. New Tracks).			Total Number of the Cross-Ties stamped of the year in col. 1 removed from tracks in year in columns 4 and 5.				Per cent. remaining in Track.		Average Life in Yrs. deduced from Renewals.	
			1902		Total Removed					
YEAR.	Main	Side	Main	Side	Main	Side	Main	Side	Main	Side
1	2	3	4	5	6	7	8	9	10	11
1898—74,516	67,091	7,425	671	75	671	75	99	99	4	4
1899—69,410	60,010	9,400	.....	.....	.....	.....	.....	.....	.....	.....
1900—76,970	65,700	11,270	.....	.....	.....	.....	.....	.....	.....	.....
1901—62,363	54,343	8,020	.....	.....	.....	.....	.....	.....	.....	.....
1902—63,561	51,483	12,078	.....	.....	.....	.....	.....	.....	.....	.....

PHILADELPHIA & READING RAILWAY.

Data completed to June 30, 1902.

	Main and Side	Main and Side								
1888.....	491,482	25,281	.....	.....	.....	.....	.....	.....	.....	.....
1889.....	599,050	43,383	.....	.....	.....	.....	.....	.....	.....	.....
1890.....	825,059	61,481	.....	.....	.....	.....	.....	.....	.....	.....
1891.....	706,773	68,862	.....	.....	.....	.....	.....	.....	.....	.....
1892.....	728,357	109,754	.....	.....	.....	.....	.....	.....	.....	.....
1893.....	688,688	164,106	.....	.....	.....	.....	.....	.....	.....	.....
1894.....	538,796	89,735	.....	.....	.....	.....	.....	.....	.....	.....
1895.....	583,491	94,712	.....	.....	.....	.....	.....	.....	.....	.....
1896.....	563,668	57,537	.....	.....	.....	.....	.....	.....	.....	.....
1897.....	531,322	17,391	.....	.....	.....	.....	.....	.....	.....	.....
1898.....	593,528	1,384	.....	.....	.....	.....	.....	.....	.....	.....
1899.....	700,679	27	.....	.....	.....	.....	.....	.....	.....	.....
1900.....	875,817	102	.....	.....	.....	.....	.....	.....	.....	.....
1901.....	972,671	.....	.....	.....	.....	.....	.....	.....	.....	.....
1902 6 mos.	519,749	.....	.....	.....	.....	.....	.....	.....	.....	.....

BOISE, NAMPA & OWYHEE RAILROAD.

Data completed to Nov. 1, 1902.

	Main	Side								
1896.....	93,000	5,280	3,580	.....	.....	.....	96.2	.....	.....	.....

RIO GRANDE, SIERRA MADRA & PACIFIC RAILWAY.

Data completed to June 30, 1902.

*1897.....	494,208	28,336	.....	.....	.....	.....	.....	.....	.....	.....

*Road constructed between November 1896, and June 1897.

TABLE II.—Southern Pacific Company, Atlantic System, number of burnettized ties removed from track during the year ending June 30, 1902.

Districts.	No. Ties Removed	Cause of Removal.						Average Life.
		Rotten.		Shivered. Broken.		Acc'd'nts and Miscellaneous No. Ties.	Per Cent.	Yrs. Mos.
		No. Ties.	Per Cent.	No. Ties.	Per Cent.			
Glidden	.....	.....	.....	.....	.....	.....	.....	.....
San Antonio	37,247	34,619	93	2,003	5	625	2	8-6
Del Rio	42,263	40,181	95	1,956	4	126	1	8-11
Sanderson	10,792	9,420	87	1,367	12	5	1	8-5
Valentine	13,557	12,349	91	800	6	408	3	9-8
El Paso	48,170	46,173	96	1,807	3	190	1	9-1
Total	152,029	142,742	94	7,933	5	1,354	1	8-11

Recapitulation of the number of burnettized ties removed from track for the years 1894, 1895, 1896, 6 months 1897 and the fiscal years ending June 30, 1898, 1899, 1900, 1901 and 1902.

Glidden	11,894	11,066	92	820	7	8	1	7-5
San Antonio	184,502	168,804	91	12,589	7	3,109	2	9-1
Del Rio	132,794	122,618	92	9,727	7	449	1	9-9
Sanderson	60,701	54,080	89	3,911	7	2,710	4	9-7
Valentine	96,076	89,092	93	5,309	6	1,675	1	8-11
El Paso	151,683	137,614	91	10,727	7	3,342	2	9-0
Total	637,650	583,274	91	43,083	7	11,293	2	9-2

TABLE III.—LIFE RECORD OF BURNETTIZED TIES ON THE SOUTHERN PACIFIC—Pacific System—to June 30, 1902.

Total Number of Burnettized Ties Laid in Tracks (inc. new tracks)		Total Number of the Cross-Ties Stamped of the Year in Column 1 Removed from Tracks in the Year in Columns 3 to 6 (both inclusive).						Per cent. Remaining in Track.	No. Years Laid in Track.
		1898	1899	1900 6 mos.	1901	1902	Total Rem'v'd		
Year.	Main and Side.	Main and Side.	Main and Side.	Main and Side.	Main and Side.	Main and Side.	Main and Side.	Main and Side.	Main and Side.
1	2	3	4	5	6	7	8	9	10
1894	81,803	130	1,013	645	2,938	7,765	12,491	85	10
1895	433,139	925	4,967	1,823	19,934	62,367	110,016	75	8
1896	475,198	329	1,737	662	12,382	55,812	70,922	85	7
1897	478,724	403	1,944	580	2,491	24,727	30,145	94	6
1898	631,056	69	722	246	3,708	11,175	15,920	98	5
1899	639,830	.....	156	99	1,660	6,040	7,955	99	4
1900, 6 mos.	486,999	.....	.....	21	522	2,723	3,266	100	3
1901	1,099,532	.....	.....	.....	35	1,135	1,170	100	2
1902	1,165,695	.....	.....	.....	.....	76	76	100	1

TABLE IV.—LIFE RECORD OF TIES ON THE CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS RAILWAY.—Chicago Division.

Data completed to December 31, 1902

Year.	Total Ties Put in Track.			Ties Removed During Year Shown.									Per cent. remaining in track on date of this report.		Average life in years deduced from renewals.	
		Main	Side	1894	1895	1896	1897	1898	1899	1900	1901	1902	Main	Side.	Main	Side.
				Main and Side.	Main and Side.	Main and Side.	Main and Side.	Main and Side.	Main and Side.	Main and Side.	Main and Side.	Main and Side.				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
½ Year, 1891.	91,092															
1892	223,340															
1893	216,350															
1894	135,873			135,324												
1895	148,593				133,157											
1896	141,401					132,156										
1897	131,268						123,389									
1898	123,175							111,115								
1899	102,339								93,164							
1900	126,617									105,955						
1901	160,963	117,655	43,303								117,655					
1902	169,778	115,768	54,010									144,294	87.69	94.25	8.00	20.00

Number of ties removed estimated. Ties not marked previous to 1901.

TABLE V.—ATCHISON, TOPEKA & SANTA FE RAILWAY.

Record of treated pine cross-ties taken out of track during the year 1902, with average life of same, and comparison with previous years.

Treated in Year.	Process.	Rio Grande Division.		New Mexico Division.		Colorado Division.		Western Division.		Middle Division.		Oklahoma Division.		Pan Handle Division.		So. Kansas Division.		Eastern Division.		Chicago Division.		Total.	
		Rotten.	Other Causes.	Rotten.	Other Causes.	Rotten.	Other Causes.	Rotten.	Other Causes.	Rotten.	Other Causes.	Rotten.	Other Causes.	Rotten.	Other Causes.	Rotten.	Other Causes.	Rotten.	Other Causes.	Rotten.	Other Causes.	Rotten.	Other Causes.
1885	Wellhouse.....	616	.....	5,262	14	.....	.....	.....	..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,878	14
1886	"	1,381	161	5,029	75	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6,410	236
1887	"	1,907	101	8,297	24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10,204	125
1888	"	3,821	20	6,981	74	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10,802	94
1889	"	2,160	5	4,770	220	.....	.....	22	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6,952	225
1890	Well. Burnet'g	2,579	20	9,021	61	.....	.....	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11,604	81
1891	Burnettizing..	2,121	189	11,335	169	69	61	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13,525	419
1892	Well. Burnet'g	3,982	634	19,068	311	77	64	167	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23,294	1,009
1893	Wellhouse.....	2,572	369	14,547	652	467	9	1,512	2	.....	90	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	19,098	1,122
1894	"	1,298	38	10,678	377	187	89	1,399	250	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13,562	754
1895	"	1,098	24	7,626	79	72	.....	999	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9,795	103
1896	"	581	33	6,754	375	7	.....	522	77	.....	.....	103	4	.....	.....	.....	.....	.....	.....	.....	.....	7,967	489
1897	"	378	19	1,354	86	.....	.....	106	.....	.....	.....	12	.....	21	1	.....	.....	.....	.....	.....	.....	1,871	106
1898	"	216	104	12	1,193	28	.....	56	.....	185	3	916	12	127	7	9	42	301	.....	.....	.....	1,850	1,361
1899	"	258	.....	.....	269	23	69	29	.....	33	8	4	.....	12	10	5	378	.....	124	.....	.....	364	858
1900	"	.....	4	.....	116	.....	.....	105	6	4	.....	.....	.....	4	7	9	210	3	36	22	.....	147	379
1901	Burnettizing..	.....	1	.....	20	.....	61	.....	.....	3	2	.....	.....	2	17	6	431	28	415	75	.....	114	947
1902	" ..	.....	.....	.....	397	.....	.....	.....	.....	.....	.....	.....	.....	.....	10	.....	98	.....	52	.....	.....	.....	557
Total taken out.....		24,968	1,722	110,734	4,512	930	353	4,921	335	225	103	1,035	16	166	52	29	1,159	332	627	97	.....	143,437	8,879

NOTE—The number of ties taken out in 1902 on New Mexico Divison is exceptionally large on account of ballasting a large portion of the main track, under the rule that ties not good for two years longer serviceishould be removed.

Treated pine cross-ties laid in track each year since 1897, also those treated in the years shown which have been removed for reasons stated.

Year in which Treated and Laid in Track.			Taken out between March 1, 1897 and Dec. 31, 1902. Entered against Year in which they were Treated.				Still in Track on Jan. 1, 1903
			Rotten.	Other Causes.	Total.		
1897	270,581	.....	2,187	244	2,431	.....	268,150
1898	648,184	.....	1,988	1,614	3,602	.....	644,582
1899	1,010,345	.....	385	1,159	1,544	.....	1,008,801
1900	1,162,509	.....	152	973	1,125	.....	1,161,384
1901	1,061,234	.....	116	1,020	1,136	.....	1,060,098
1902	1,040,455	.....	.....	557	557	.....	1,039,898
Total.....	5,193,308	.....	4,828	5,567	10,395	.....	5,182,913

NOTE—No statistics were kept prior to 1897 of treated ties taken out, consequently this statement does not show the proportion that the total number taken out to date bears to the total number originally put in, it can only show the average service of those removed, excepting since 1897, and for this period the total number put in and removed for cause is given.

TABLE VI.—TREATED TIES LAID AND RENEWED, BY

Year Treated..		1887	1888	1889	1890	1891	1892	1893
No. of Treated Ties Laid same Year		4,144	118,098	196,365	212,677	180,670	247,179	179,229
Removed Each Year.	Year Removed.							
	1893	472	3,199	528	69	.....	.....	.....
	1894	1,020	3,602	547	67	8	.....	.....
	1895	1,156	10,665	3,337	940	185	46	269
	1896	1,401	16,883	5,545	3,536	936	336	177
	1897	95	9,419	3,867	4,424	1,035	444	120
	1898	.....	20,638	12,517	9,706	4,293	3,845	1,504
	1899	.....	29,935	17,487	13,192	5,227	3,790	1,023
	1900	.....	23,757	28,580	45,126	28,360	10,981	4,881
	1901	.....	.....	68,322	36,139	14,073	10,871	4,857
	1902	.....	.....	55,635	63,998	9,749	11,015	4,324
Total Number Renewed		4,144	118,098	196,365	177,197	63,866	41,328	17,155
Number of Years Laid in Track on July 1, 1902		10	12	13	12	11	10	9
Percentage Remaining in Track July 1, 1902		.....	.....	.....	17	64	83	90

TABLE VII.—QUEENSLAND RAILWAYS—AVERAGE AGE OF SLEEPERS

Timber.	Brisbane.		Too'mba.		Roma.		Maryboro		Rkhpth.		Mackay.		Bowen	
	Squared	Half Round	Squared	Half Round	Squared	Half Round	Squared	Half Round	Squared	Half Round	Squared	Half Round	Squared	Half Round
	Yrs.	Yrs.	Yrs.	Yrs.	Yrs.	Yrs.	Yrs.	Yrs.	Yrs.	Yrs.	Yrs.	Yrs.	Yrs.	Yrs.
Blackbutt	11.16	9.66	20.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Bloodwood	11.38	11.85	10.00	17.51	.....	.....	.....	18.05	.....	16.00	.....	.....	.....	.....
Boxwood	.....	.....	.....	20.16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cyp. Pine	.....	.....	.....	.....	.....	20.88	.....	.....	.....	.....	.....	.....	.....	.....
Gum, Blue	.....	14.00	.....	.....	.....	.....	9.00	18.00	.....	.....	.....	.....	.....	.....
" Cab.	.....	.....	.....	18.37	.....	.....	7.82	.....	.....	.....	.....	.....	.....	.....
" Gray	.....	14.00	.....	20.17	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
" Pop.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
" Red.	.....	.....	.....	20.00	.....	.....	13.00	13.00	.....	.....	.....	.....	.....	.....
" Spot	11.59	15.87	16.00	17.00	.....	.....	9.18	13.37	.....	.....	14.92	.....	.....	.....
Hickory.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Ironbark	11.48	14.76	21.06	25.75	.....	20.91	15.56	16.79	.....	16.52	10.00	16.80	.....	10.63
Ironwood	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
M. B. Ash	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Messmate	.....	.....	.....	.....	.....	.....	.....	20.00	.....	.....	.....	.....	.....	.....
Penda	.....	.....	10.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pud. Wood	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R. S. Bark	13.36	15.57	9.00	20.00	.....	.....	9.33	20.13	.....	.....	.....	.....	.....	.....
S. Mahogany	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Tal. Wood	.....	13.00	5.71	.....	.....	22.00	9.00	19.88	.....	.....	.....	.....	.....	.....
Turpentine	10.00	.....	.....	.....	.....	.....	9.00	.....	.....	.....	.....	.....	.....	.....
Tea Tree	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Average age of all timbers, squared and half round, 16.81 years; number 536,676.
Particulars have been obtained of only a portion of the total number of sleepers renewed.
Owing to squared sleepers only having been adopted in recent years, their average age
Cypress pine sleepers have not been put in road for many years, and thus only the very

YEARS, SOUTHERN PACIFIC COMPANY, ATLANTIC SYSTEM.

1894	1895	1896	1897	1898	1899	1900	1901	1902	
190,769	190,802	165,783	86,737	152,329	207,555	342,335	292,493	204,217	2,971,382
									Total Removed
.....	.....	.....	.....	.....	.....	.....	.....	.....	4,268
.....	.....	.....	.....	.....	.....	.....	.....	.....	5,244
6	.....	.....	.....	.....	.....	.....	.....	.....	16,604
18	129	.....	.....	.....	.....	.....	.....	.....	28,961
79	1	1	.....	.....	.....	.....	.....	.....	19,485
493	110	165	1	30	.....	.....	.....	.....	53,302
448	230	7	46	104	.....	.....	.....	.....	71,489
3,938	1,350	1,367	22	529	33	.....	.....	.....	148,924
1,688	620	748	308	2,665	274	420	627	.....	141,612
3,648	1,802	592	44	110	538	283	20	271	152,029
10,318	4,242	2,880	421	3,438	845	603	647	271	641,918
8	7	6	5	4	3	2	1	.....	.....
94	97	98	99	.....	.....	.....	.....	.....	.....

RENEWED FOR FOUR YEARS ENDING DECEMBER 31, 1901.

Townsville.		Cairns.		Cooktown.		Normanton		For the Whole State.				Timber.
								Squared.		Half Round		
Squared	Half Round	Squared	Half Round	Squared	Half Round	Squared	Half Round	No.	Age.	No.	Age.	
Yrs.	Yrs.	Yrs.	Yrs.	Yrs.	Yrs.	Yrs.	Yrs.					
.....	.....	.....	.....	.....	.....	.....	.....	2212	11.85	15	9.66	Blackbutt.
.....	17.89	11.36	8.25	.....	14.77	.....	9.74	983	11.35	29,886	9.82	Bloodwood.
.....	.....	.....	.....	.....	15.00	.....	.....	.....	.....	321	20.06	Boxwood.
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	19,545	20.88	Cyp. Pine.
.....	.....	.....	.....	.....	.....	10.36	.....	1721	10.35	170	17.70	Gum, Blue.
.....	.....	.....	.....	.....	.....	.....	.....	39	7.82	513	18.37	" Cab.
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	189	17.83	" Gray.
.....	18.46	.....	.....	.....	.....	.....	.....	.....	.....	120	18.46	" Pop.
.....	.....	.....	.....	.....	.....	.....	.....	190	13.00	211	13.39	" Red.
.....	.....	.....	.....	.....	13.04	.....	.....	3132	9.91	1,014	14.74	" Spot
.....	.....	11.24	9.49	.....	.....	.....	.....	3172	11.24	1,939	9.48	Hickory.
14.25	16.28	.....	13.57	.....	15.31	9.00	10.80	11100	17.44	439,547	17.40	Ironbark.
.....	.....	.....	.....	.....	12.23	.....	.....	.....	.....	226	12.23	Ironwood.
.....	18.00	.....	.....	.....	13.68	.....	.....	.....	.....	1,797	13.68	M. B. Ash.
.....	.....	9.36	9.37	.....	.....	.....	.....	3419	9.36	3,829	9.48	Messmate.
.....	.....	.....	.....	.....	.....	.....	.....	395	10.00	.....	.....	Penda.
.....	14.25	.....	.....	.....	.....	.....	.....	.....	.....	443	14.25	Pud. Wood.
.....	.....	.....	.....	.....	14.00	.....	.....	583	9.40	3,184	19.24	R. S. Bark.
.....	.....	.....	.....	.....	15.31	.....	.....	.....	.....	1,049	16.26	S. Mahogany
.....	.....	.....	.....	.....	.....	.....	.....	435	8.73	5,195	19.40	Tal. Wood.
.....	.....	.....	.....	.....	.....	.....	.....	66	9.00	.....	.....	Turpentine.
.....	15.00	.....	.....	.....	.....	.....	.....	.....	.....	36	15.00	Tea Tree.
Total No. and Average Age, all Timbers.....								27447	13.22	509,229	17.01	

at present appears to disadvantage compared with half round sleepers.
best are now in road for renewal, hence their apparently excessive life.

TABLE VIII.—TIE STATISTICS OF THE MADRAS (INDIA) RAILWAY.

For the half year ending June 30, 1902.

DETAILS.	Kinds of Wood Transverse.										Total	Creosoted Pine Sleepers.	Iron Bowl Sleepers.
	Teak.					Indian Junglewood Sleepers of different description.							
	16'x12" x6"	14'x12" x6"	12'x12" x6"	10'x12" x6"	10'x10" x5"	10'x12" x6"	10'x10" x5"	11'x9" x5"	10'x9" x5"	9'x9" x5"			
Number of sleepers in way, including sidings, at the commencement of the half year	2,711	200	5,655	3,297	7,918	5,824	19,843	140	280	56,835	102,703	1,383	3,336,842
Average age of sleepers in way at the end of the half year.....Years	18 3375	21 6080	24.5763	9 5958	19 5976	4 3013	6.8842	5369	.5278	.5794	3.5667	4.4879	29.7019
Number removed	22		33	7	23	513	658				*1,256		* 7,638
Number laid	167	10	24	298	164	590	1,242	104	224	29,442	*32,265	6	* 17,223
Percentage of removals on total of each class	.8115		.5836	.2123	.2905	8.8084	3.3160				1.2229		.2289
Number of sleepers in way, including sidings, at the end of the half year	2,856	210	5,646	3,588	8,059	5,901	20,427	244	504	86,277	133,712	1,389	3,346,427

*The difference between removed and laid is owing to increase in mileage of main line and sidings.

(G) REPORT ON TEXAS TRACK.

By Hermann Von Schrenck.

In February, 1902, an experimental section of track was laid on the Beaumont Division of the Gulf, Colorado & Santa Fe Railway. In this track both treated and untreated timbers of various kinds were laid to test the comparative lasting powers of timbers treated with various kinds of treatment. These ties have now been in position about two years, and while it is as yet rather early to derive any definite conclusions from this test, an inspection made during the month of December showed the following general results:

(1) All of the untreated timbers show more or less signs of decay. Tamarack, Loblolly Pine and Beech have so far shown themselves as the least resistant of all the timbers. In the case of the untreated Tamarack, out of 49 ties, 37 had fungi growing on the ends of the ties, indicating that they were beginning to decay. The various species of Oak showed the highest resistance in the untreated state.

(2) Referring to the treated timbers, the most striking results so far evident refer to the bad results with Oak timbers which were overheated in the treatment with creosote. These timbers were for a brief period of time exposed to an extreme heat. A large percentage of the ties so treated have during the last year or so broken in the middle or underneath the rail bearing, so as to endanger the safety of the track, and they had to be removed. Great stress should be laid upon the results in this particular instance, which should serve as a warning to avoid excessive heating, whether the same be dry or moist heat.

(3) The ties treated with the zinc-chloride process have so far shown no signs of decay, and there is little evidence of any wear under the rail. The same is true of the ties treated by the zinc-creosote, two-injection process.

(4) Ties treated with spirittine are in every case sound.

(5) Summing up the results which are so far evident, one can say that every treatment has so far protected the timbers against decay, and, in view of the fact that all of the untreated timbers are decaying, this stretch of track is already forming an object lesson of great interest as to the value of treated timbers. A full report, with details, is now in process of being printed as a Bulletin of the Bureau of Forestry.

(6) Some of the ties treated with the Barschall process have fungi growing on the ends. These are, however, a lot of ties which were poorly treated, and it is not thought that the appearance of these fungi on the ends warrants the conclusion that this treatment will not protect the timber

against decay. Another year ought to be allowed to elapse before any definite conclusion is drawn.

PROGRESS IN TIMBER TREATMENT.

During the past year a number of modifications in the treatment of various timbers have been made, of which the following may be noted:

(1) *Treatment of seasoned pine timbers with zinc-chloride without steaming.*

The value of seasoning pine timbers before treatment has been urged for a number of years. In hardly any case is timber steamed in Europe before being treated. During the last summer, tests were made at the Las Vegas treating plant of the Santa Fe, with seasoned Mountain Pine, with the following results:

Absolutely dry, air-seasoned timber was put into the cylinder, and the following is a record of a run:

Vacuum begun	5:50 p. m.
21 in. vacuum reached	6:50 p. m.
Zinc-chloride pumped in	6:50 p. m.
80 lbs. pressure reached at	7:15 p. m.
Started forcing back	10:15 p. m.
Completed	10:35 p. m.
Total time of treatment	three hours 45 minutes

The ties were carefully weighed before and after treatment, and when the treatment was finished they showed an average gain in weight, because of the solution absorbed, of 84.22 per cent. The solution had thoroughly penetrated the wood. This test was repeated a number of times with the same results, and since those tests were made the steaming operation, which is not only a lengthy one, but costly likewise, has been eliminated from the treatment.

Similar tests are now under way at the treating plants of the Burlington & Missouri River Railroad in Nebraska and at Somerville, Tex. Attention should be called to the fact that this treatment will only succeed with absolutely dry timber. In view of the fact that the penetration is so much greater and takes place with so much greater rapidity, and, furthermore, in view of the fact that the heating is left out, it is believed to be a great improvement over the present method of treatment. Further tests are now in progress, and the details will be published in full.

(2) *Creosoting.*

An increasing amount of creosoting is being done at the present time, and the necessity for a careful inspection of the oil is being realized more and more. It is generally being realized that only a good oil will serve the purpose. What constitutes a good oil is a matter which has been much discussed. In spite of many researches conducted in this country and in Europe, it has not yet been decided whether (referring now only to ties or bridge materials) any one of four or five compounds is the essential constituent of good tar oil. What is known, however, is

that tar oil, in order to be of a high grade, should have such products in it as will not disappear from the wood when the same is exposed to atmospheric influences, but that will remain in the wood for indefinite periods. Every inspection ought to determine whether the tar oil has this quality of remaining in the wood. This method of inspection should be simple, easy and one which can be rapidly executed by almost anyone. The following set of specifications are being urged by the Department of Agriculture as to what constitutes high-grade oil:

(1) The tar oil must be clear; that is, there must be no substances in suspension. This is best tested by putting a drop of the oil on a piece of filter paper. The resulting spot must be clear and translucent.

(2) The specific gravity must be about 1.04 to 1.05 at a temperature of 20° C., 68 F.

(3) Boiling points. Up to 150° C. nothing must come off. Up to 200° C. not more than 10 per cent. may come off. Up to 235° C. not more than 25 per cent. may come off. Up to 355° C. at least 90 per cent. must come off.

(4) The oil must be absolutely soluble in benzene or absolute alcohol.

(3) *New processes:*

During the past year a number of new processes have been advocated for treating ties. Two of these deserve special attention. They are both still in the experimental stage and require careful testing before being adopted.

(1) *Rüping process of creosoting.*

This process is one which aims to save a certain portion of the creosote now injected into the timber, thereby cheapening the process. Its method of operation may be briefly stated as follows: Absolutely dry air-seasoned wood is put into a treating cylinder, and compressed air pumped into the cylinder up to 5 atmospheres; this pressure is kept about one hour. Tar oil is then pumped in under a pressure of about 85 lbs. until the cylinder is full, and the pressure is then raised to 14 or 15 atmospheres. This pressure is left on until the wood has absorbed as much of the oil as it can. The pressure is then taken off entirely, the oil is run out, and a vacuum is created. The compressed air contained in the wood cells then presses out any excess oil not held by the fibers of the wood. It is claimed that this process saves practically 50 to 60 per cent. of the quantity of oil ordinarily used for the treatment. Trial tests, made at Norfolk, Va., by the writer, and similar tests made near Berlin during the past summer, have, to a large extent, sustained these claims. Extensive tests are now under way with this process, and should it prove practical to treat American timbers so that they will absorb only a small quantity of tar oil and still give extensive penetration, this process would recommend itself highly. It would mean treating timbers with creosote for about the same price that it now costs to treat with zinc-chloride.

(2) *Chrome-alum process.*

The Chrome-Alum Process is one invented by Kester, of Munich. The theory of the process is briefly as follows: The inventor states that

the chief difficulty with salts of various kinds used for treating timber has been that the salts are soluble in water, and leach out. For a preserving solution, he uses chrome-alum and acid-sodium sulphate. These two salts, when in solution cold, do not unite, but when the solution is heated to 80° C., the two salts unite and form an insoluble chromium salt. The manner in which this process is operated is as follows: The two salts are mixed in solution (cold) and are pressed into the wood under a pressure of about 4 atmospheres. Steam is then turned into the cylinder for the purpose of heating the wood, and when the same is heated to about 70 or 80° C., the insoluble chromium salt is precipitated in the wood cells. The inventor claims that the treatment can be made for about 7 cents per tie. No practical tests have yet been made with the process beyond the treatment of 25 ties by the Bavarian State Railways during the past summer.

(3) *Giussani process.*

This is a process for which two large plants are now in operation on the Italian railroads. The treatment depends upon heating the air in the wood so that a portion escapes, making a partial vacuum. The wood is then dropped into a cold solution of tar oil or zinc-chloride, thereby bringing about a penetration of the preservative. The manner in which the treatment is carried on is as follows:

The ties are plunged into a hot bath of tar oil by automatic machinery and slowly moved through the tank for varying periods of time, when they are dropped into a tank containing cold tar oil. The hot oil having heated the tie, when it is dropped into the cold oil a partial vacuum is made in the tie, and the cold oil rushes in, securing a penetration of two to three inches. This process recommends itself because the plant required is very much cheaper than for the cylinder process. Tests are being planned with this process to determine the relative cost of treatment between it and the old cylinder process.

MECHANICAL DEVICES FOR PREVENTING WEAR OF SPIKES.

A device has been in use in Europe for some years which has given such remarkable results that it is worthy of attention in this country. The great trouble with soft ties is, and always will be, the rate with which the wood around the spike wears out. Treated ties of softer pines and the inferior oaks are rapidly wearing out at the spike holes, necessitating respiking, and in many instances the entire removal of the ties, because of the decay which sets in at the spike holes. The device spoken of, which is called a screw dowel, or trenail, has now been in use in Germany and France for some 5 years, and has given the most satisfactory results. The screw dowel consists of a cylindrical piece of beech wood, provided with a broad thread. The upper part of the dowel is somewhat larger than the body. A hole somewhat less than the diameter of the screw or spike is bored through the center of the dowel. The dowel is heavily creosoted. The dowel is put into the tie in the following manner: A hole is bored somewhat less than the diameter of the dowel, and by means of a threading device a thread is cut in this hole. The dowel is then

screwed in either by hand, when there are a few ties to be provided with dowels, or by machinery, when a large number are to be provided. In France and Germany the doweling process is usually carried out in connection with the treating plants. The dowel makes a perfect fit with the tie and prevents the water from getting into the space between the dowel and the tie. The screw or spike is inserted into the dowel much as it would be screwed or driven into the tie. Should any of the wood around the spike wear out, the dowel is removed and another is screwed in its place. The body of the tie is thereby saved from destruction. The tops of the dowels at the same time act as tie-plates, preventing the wearing out of the wood of the tie, and in many cases have rendered the use of the expensive steel plate almost unnecessary. A further advantage of the dowel consists in the very much increased holding power which the dowel gives to the spike or screw, principally in the matter of resisting the lateral pressure. The great area of surface of the dowel makes this possible. On recent high-speed tests made on the stretch Berlin-Zossen on the German military road, all the ties were provided with dowels, and the inspecting military officers report that there was practically no deviation from the normal gauge where these dowels were used, whereas in former years the difficulty had been that the track had spread so as to endanger the safety of the train. The dowels, when made in quantity, are extremely cheap, and it is believed that they ought to prove a valuable means for making possible the use of the softer wood timbers in this country. Extensive tests with the dowels are now being planned, and it is urged that short stretches of track be provided with them wherever possible.

(H) WRITTEN DISCUSSION.

UNION PACIFIC RAILROAD COMPANY.

WOOD PRESERVING WORKS.

LARAMIE, WYO., October 29, 1903.

MR. J. B. BERRY, Chief Engineer, Omaha, Neb.

Dear Sir:—I return herewith Bulletin No. 43, issued September, 1903, by the American Railway Engineering and Maintenance of Way Association, with comments on same, as requested by you.

Referring to data submitted by Mr. Mudge, of the Atchison, Topeka & Santa Fe Railway, given on page 5, article 4, you will note the average life of ties treated with the Burnett process or straight zinc-chloride (1901 and 1902) compare very favorably with ties treated with the Wellhouse process or zinc-tannin. There is very little comparative data along this line to be found, but in all that I have seen, ties treated with zinc-chloride show nearly as good results as ties treated with zinc-tannin.

A good deal of stress is put on the necessity of seasoning ties before treatment. It has been our aim to season all ties thoroughly before treatment, and pine ties, such as we are treating, will thoroughly season in about ninety days, especially in this dry climate.

In experiments which Dr. Hermann Von Schrenk has carried on, ties were piled in different ways, and as a result ties cribbed open and

half open, lost more moisture in a specified length of time than ties piled in a close pile, same as the method we employ, *but I do not believe the decrease in the length of time of seasoning sufficient to warrant the extra expense of cribbing.*

From our own experience, ties that have been seasoned are much easier and more thoroughly treated than green ties; that is, steaming has a greater effect and the penetration of solution is easier and more thorough.

There is one point in this connection I do not think enough attention is paid to, and that is the cutting of ties at different seasons of the year. Obviously, ties cut in the winter months are more free from sap than ties cut in the summer months, and, as a consequence, would season in less time, though it has been demonstrated that ties do not season in freezing weather. Then, again, ties cut in the fall are more durable than ties cut in the summer months, for timber is most durable when cut at a time it contains the least sap, and because the low temperature of the winter season prevents the attack of the fungi, and wood is thus given a fair chance to dry. Usually, summer felled wood, on account of prevalent high temperatures and exposure to sun, checks more than winter felled wood, and since all season checks favor the entrance of moisture and fungus, they facilitate destruction.

It is a practice on some roads, and I believe a very good one, when treated ties are distributed along the right of way, instead of throwing out of cars and permitted to lay on the ground haphazard, they are piled in triangular piles. This gives the ties the best opportunity possible to season before placing in the track. This would be especially beneficial when ties are to be placed in a moist climate.

It is a grave question among men interested in the preservation of timber, not only in this country but in foreign countries, as to just how much zinc-chloride should be injected into each cubic foot of timber in order to get the best results. Please note paragraph 4, on page 8. As you are aware, we are injecting .4 of a pound per cubic foot, but it is questionable whether or not this is sufficient to obtain the best results. Very few are using less than .5 of a pound, while some are going as high as .7 of a pound per cubic foot. It is possible that .4 of a pound would be sufficient for ties that are used in dry climates, such as Western Nebraska, Western Kansas and Wyoming, but when ties are to be laid in the track in moist climates, such as Eastern Nebraska, Eastern Kansas, or where the rainfall is considerable, I firmly believe .5 of a pound of zinc-chloride should be injected per cubic foot.

I recently had two ties removed from the track which had been treated at the former plant at Laramie and laid in the track west of Rawlins in 1886. These ties were in a fairly good condition. The tops of the ties were sound, but the bottoms had been somewhat affected by dry rot. Whether or not zinc-chloride formed the basis of the preservatives at that time I can not say, but, from a chemical analysis, *no chloride was found.* If zinc-chloride was used, it is impossible to say how long the ties had been free from the preservative. I am trying to find some data regarding the process used at the old plant and espe-

cially how much chloride of zinc was injected per cubic foot, but, judging from the condition of the ties referred to in the above, if more chloride had been injected their life would have been prolonged.

From the fact that data regarding that plant is lacking, it serves to emphasize the fact that too much care can not be taken in order to keep a complete and accurate record of ties treated.

Referring to the discussion relative to the system used in marking ties, I agree that a dating nail is superior to notching or stamping with dating hammer, but since any germs of decay can begin their destructive work soon after treatment, and since a good many ties remain out of the track some time after treatment, it seems to me that the nails should be put in the ties before they leave the plant.

Beginning on page 13 of the accompanying Bulletin, there is some discussion relative to the necessity of a laboratory in connection with wood-preserving works. I am confident that the best results can not be obtained without the practical laboratory tests being made at the plant. From our experience, we have made slight changes in the operation of treatment and in mixing solutions as a direct result of such tests. Samples of the salts received are taken from each car and analysis made, and it not only serves as a check on the shippers, but we know at all times the exact purity of the chemicals we are handling. At the end of each month we check the amount of chloride on hand against the total amount of chloride used in previous months, plus the amount on hand, which gives us an accurate check on our calculations in mixing solutions. We have made it a practice to make at regular intervals analysis of treated ties, and consider this feature alone sufficient cause for the extra expense of maintaining a laboratory, which is in itself quite inexpensive.

In connection with the laboratory we use a microscope in determining the condition of timber after steaming and after treatment. It is a question as to just what temperature timber can be subjected without injuring the fibers of the wood, and with the aid of the microscope we can tell whether or not the fibers have been expanded to an injurious extent. It can easily be ascertained whether or not solution has penetrated the tie or not, for if it has it can be seen as easily as protoplasm. Then, in the study of fungous growths, a microscope is indispensable. Too much care in the different steps of the operation of treatment can not be taken, and all tests and experiments which will aid in determining the exact nature of results should be taken.

On page 9, article 7, you will note that the Germans and the French use automatic gauges with clock connections to record their vacuums and pressures and the time of each. I think this a very good idea, for, since we can not be with the engineer all of the time, especially at night, he may at times become careless and either have too high or too low a pressure, but if automatic gauges were used, as referred to above, we would have a check on the work.

There is one suggestion I would very respectfully make, which, it seems, would be of inestimable value to managers of plants, though it may not be deemed advisable by railroad managers. Why could there not be a meeting or conference of managers of wood-preserving works

throughout the country? The difficulties they encounter in the actual operation of the plants are many, and a discussion of remedies would be of mutual benefit. The theoretical workings of a plant and the actual every-day experience are vastly different. To my knowledge, there never has been a meeting of the managers of plants, and, judging from the amount of money that is being expended in timber preservation, the time is about ripe when a great deal of benefit would be reaped from a meeting of men who, from day to day, are confronting difficulties, the remedies for which there is such a wide diversity of opinion.

If managers of tie-treating plants were permitted to visit the various plants over the country, great profit would be gained, for there are innumerable points of arrangements and management which would never be gained in any other way than by personal observation.

Yours truly,

C. W. BERRY, Superintendent.

MR. W. C. CUSHING (Pennsylvania Lines—by letter) :—I do not agree with certain definitions submitted by the Committee, and suggest the following changes:

POLE TIE.—A tie hewed on top and bottom and left rounded on the two sides. Not more than one tie can be made from a section of tree.

SPLIT TIE.—A tie split or hewed on all four faces.

QUARTERED TIE.—A tie hewed on top, bottom and one side, and left rounded on the other side. Not more than four ties can be made from a section of a tree.

SLAB TIE.—A tie sawed on top and bottom and left rounded on the sides.

DOTY TIE.—I have not been able to find the word doty in Webster's Dictionary.

PRESERVATIVE PROCESSES.—Under this head I do not think the Committee have been quite explicit enough on account of having omitted to state the kind of treatment to which the ties were submitted and the material with which they were treated.

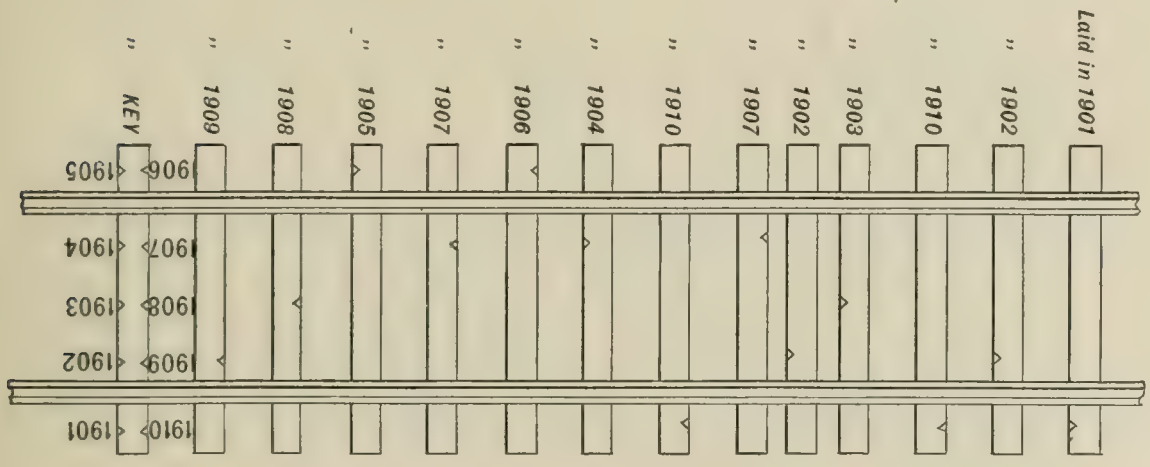
MR. WALTER G. BERG (Lehigh Valley—by letter) :—I have always considered that a metallic salt process, such as, for instance, the zinc-tannin or zinc-chloride process, is the proper process to use for preserving ties, because it is comparatively cheap and yet adds to the life of the tie a sufficient period to warrant the expense. It is not as good as the creosoting process, but it costs only about one-third as much. A softwood treated tie will wear out by cutting, unless protected by tie-plates, long before it will decay or the value of the antiseptic be lost. It is not a question of getting absolutely the best at any price, but to adopt that process which insures financial economy in the long run, taking all conditions of the service into account.

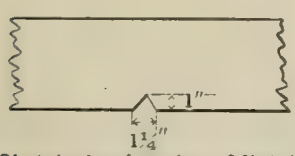
In spite of the fact that I designed and built creosoting works for the Lehigh Valley Railroad at Perth Amboy in 1886 and subsequently

operated same for the railroad company for six years, I was always endeavoring to have the zinc process added to the works as an adjunct for use in treating ties. We treated a large number of experimental softwood ties with creosote, and the bulk of these are still in use after fourteen years' service in yard tracks, but the ties were protected from cutting by tie-plates.

There is no question that the treatment of cheap softwood ties by the zinc process, costing from 12 to 15 cents per tie, even if tie-plates are used, will prove economical in the long run. It is generally, however, a question whether a railroad management desires to increase operating expenses in order to insure future profits years hence. If the property can be handled in a broad and correct manner, the treating of ties by some cheap metallic salt process will be indicated.

Mr. W. J. Wilgus furnishes the following sketch illustrating the standard method of notching for determining the life of ties in use on the New York Central & Hudson River Railroad:





Sketch showing size of Notch

Note.—Determine position of notch with reference to base of rail by actual measurement. All notches for any one year should be in a line parallel with the rail.

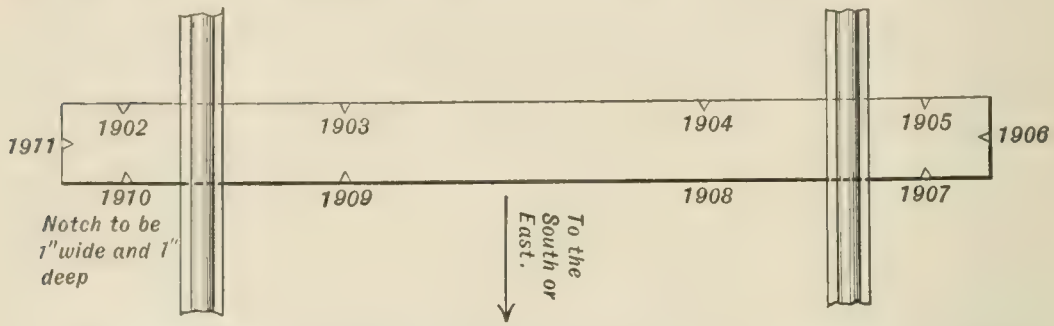
Mr. F. H. Alfred (Pere Marquette—by letter) :—I do not fully concur with the plan concerning the system of marking cross-ties, advocated in the report of the Committee on Ties, as submitted at the third annual meeting, for the following reasons: First, it is not desirable to place a record on the track ties which can be read by the public; second, the cost of nails, while but a small detail, would amount to a considerable sum on a system putting in from half a million to a million ties per annum; third, the notch is more easily read by those having the key.

Previous to this year there was no systematic attempt made to keep a record of this kind, but all ties put in during 1902 have been notched

as shown on the accompanying sketch; ties put in hereafter will be marked as shown in the sketch. This will take care of all ties put in up to 1912, at which time a new series can be started. There will be no danger of confusion, as the condition of the ties put in during the first ten-year period would, of course, distinguish them from those put in during the second period.

The notching is done by the section foreman, and we figure that the cost may for obvious reasons be disregarded. So far as records are concerned the same results are obtained as by the method recommended by the Committee.

However, if the Committee can offer sufficient reasons for inducing us to change our practice, I shall be very glad indeed to consider them.



Mr. J. B. Berry (Union Pacific—by letter) :—Referring to the method of marking cross-ties by notching, in use on the Pere Marquette Railroad, I cannot see anything to commend this method of marking ties. First, what is the objection if the public do know when ties were put in track, or the life of them? We are continually printing publications on the average life of ties. They could get it that way. Second, every section foreman or employé whose business it was to cut notches in the ties would be obliged to carry a key along with him, and, in many cases, with the class of labor we have, they would be apt to make many mistakes and notch them in the wrong place; also, in taking the ties out, would make mistakes, as they are not bookkeepers. It would take much more time to notch them than it would to drive a nail; but more serious than either of these is the question of cutting into timber after it has once been sawed, hewn or treated, and, in my opinion, it should not be done. Nails, such as we would use, No. 3 galvanized wire, 2½ in. long, with a head ½ in. diameter, and a number on it, would cost 1-5 cent apiece. They are easy to put in, easy to identify, and make it as easy as possible for the employé to keep his records.

Mr. R. R. Hammond (Chicago & Eastern Illinois—by letter) :—Referring to the letter from Chief Engineer Alfred, of the Pere Marquette, offering some objections to the system of marking ties which was advocated in the report of the Committee on Ties, and submitted at the third annual convention, I do not think there is any merit in his objection to placing a mark on ties which can be read by the public. If an accident occurred, due to rotten ties, the appearance of the tie itself would impress the

public much more than the record. For instance, if a rotten tie was found in the track at such a time, no matter if it had only been in service three years, the railway company would be blamed. On the contrary, if the tie was reasonably sound, I imagine no fault would be found, although the record might show that the tie had been in the track for fifteen years. I can see no serious objection to Mr. Alfred's plan for marking ties, except that I think it is a little more difficult to read the date, and that there is considerable danger of same being obliterated by erosion, or by decay, long before the tie has reached a point where it is necessary to remove it from the track, especially in case of a tie with some sap on the edges. We have been using nails with date stamped on the head for something over two years on this system, and have found it inexpensive and very satisfactory, the nails being applied before the ties are forwarded from the tie yard, or treating plant. In this way we have no difficulty in having the nails applied, whereas, if you trust their application or even the notching of the ties to the section men, I believe it will be found very difficult to secure a record that would be of any value.

Dr. Hermann Von Schrenk (Bureau of Plant Industry, Dept. of Agriculture—by letter) :—I can see very grave objections to the notching of timber. In the first place, it is a most inexact way of getting any lengthy records. If it is intended to mark one year, one notch on one side or the other of the tie would be a very satisfactory way to mark it, but after you get seven or eight years of marking, so complicated a system would have been developed, that it would be very confusing. I seriously doubt whether it will be possible to have sectionmen notch ties with sufficient care to put them at the right place to keep such a record. The notching business has been tried before, and, so far as I am aware, no one has ever been able to show any results which amounted to anything therefrom. As to the objection made that it is not desirable to place a record on the track which can be read by the public, I regard it as a trivial objection. The public, as a rule, is not interested at all in the life of cross-ties, and, if they were, there are abundant ways and means of their determining such life very much easier than walking up and down the right of way and counting the nails. I can see a good deal more reason for small boys and others going along and chopping marks into ties, to the utter confusion of the sectionmen who endeavor to keep a record. The most serious objection that I have to the notching is that any injury which you make in the tie forms a foothold for destructive agents to affect the fiber, and that is exactly what we are trying to prevent in order to increase the length of life of the ties.

QUEENSLAND RAILWAYS.

Brisbane, March 6, 1903.

To the Secretary, American Railway Engineering and Maintenance of Way Association, 1562 Monadnock Block, Chicago, Ill.

Sir:—I was interested to read in the Railroad Gazette of December 5, 1902, page 925, what your Association is doing in the way of recording

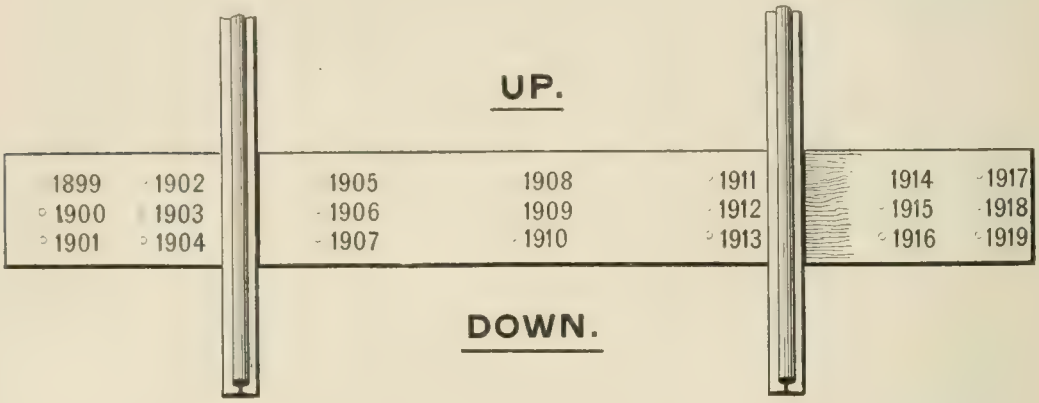
the life of cross-ties, or, as we call them, sleepers. In this state for the past five years we have been keeping records, and I send you, for your information, results of the first four years' returns.

The names at the head of the table indicate the districts into which the railways of the state are subdivided. I also enclose instruction showing how the date of the sleeper put in the road has been kept in the past, but I may say that we are now using the date nails from America, as being, if anything, cheaper than boring a hole.

I should be glad to receive from you copy of your blank forms to see the system in which the records are kept in your country.

Yours faithfully,

WILLIAM PAGAN,
Chief Engineer.



To definitely fix the age of sleepers when renewed, bore an auger hole in all sleepers, when being placed in the road, in the position shown on sketch, corresponding with the year in which the sleeper is renewed.

"UP" and "DOWN" are the directions as defined by the working timetable existing at the time of sleeper renewal. One hole right through the sleeper is to be bored in each sleeper, and it should be done with the same auger that is used for boring dog spike holes.

MR. V. K. HENDRICKS (Baltimore & Ohio—by letter):—In regard to the supplementary report of Committee No. 3, on Ties, I would suggest that in the Specifications, Wild Cherry and Mulberry be added to the list of woods which might be used as tie timber without any preservative treatment, and that this list of woods be divided into two classes, the White Cedar, Chestnut, Catalpa and Mulberry being one class, and the balance in the other class, this division being made on account of the fact that the second class referred to would not ordinarily require tie-plates, while the first class named would require tie-plates under most conditions.

As some of the railroad companies treat their own ties, it is recommended that the paragraph between the list of untreated and treated ties be made to read: "The following woods shall not be used for tie timber without a preservative treatment approved by the purchaser, but may be purchased untreated under special contract."

On page 19, just below the table of dimensions, it is suggested, in view of the fact that all ties will not be delivered along the right of way, that the paragraph be made to read: "Ties to be delivered along the right of way of the railroad must be piled at station yards, or at points . . . ;"

also that to this paragraph be added: "Contractors, in shipping, must load only one grade of ties on a car, unless otherwise specified," and that an additional paragraph be inserted reading: "Rejected ties must be removed from the company's right of way within 10 days after notice has been given."

One question not mentioned in this report is that of cultivating Black Locust or Hardy Catalpa trees for obtaining the necessary tie supply in the future. After consulting some of the best authorities on this subject it appears that, if railroad companies were willing to incur the additional expense until such time as the trees would mature, probably some time between fifteen and twenty-five years, if the planting has been intelligently done in every way, they would not only insure a sufficient tie supply of the very best kind for the future, but would obtain that supply at a cost less than the average cost at this time for the ties themselves, disregarding the fact that their life would be longer than the life of ties now ordinarily used. Inside of some ten or twelve years after the first crop of ties (supposing land to cost $25.00 per acre), the excess cost during the time of cultivation, together with five per cent. compound interest on same, would be regained by the saving after the first crop, and after that time the question of interest could be dropped. As there would be no land to buy after the first crop of ties, the total cost, after interest is eliminated, would merely be the cost of taxes, cultivation and marketing, which would probably not be over 23 or 24 cents per tie, after allowing three cents per tie for hauling to the railroad. Such ties should easily have a life of 15 years, and, so far as decay is concerned, much longer. Of course, tree cultivation is not practicable everywhere, but is believed to be generally practicable, and it does not require the selection of the land best suited for farming land. I should like to see this question carefully considered, as the benefits, while not obtained for some 20 or 25 years, are so great even as compared with present prices; as compared with prices 20 or 25 years hence, they must be much greater.

DISCUSSION.

Mr. W. W. Curtis (Consulting Engineer):—I want to say for the Committee that their absence to-day is not an indication of their lack of interest or of their absence from committee meetings. If necessary for them to be absent from this meeting or the Committee's meetings, it would be better to cut the convention out and attend to the business of the Committee. The report as presented is not a one-man report by any means. The Committee has devoted considerable time to it and has gone over it very carefully. I do not know that there are points I want to call attention to, unless in reply to questions. There have been two Bulletins issued, one, No. 43, last September, which was the report as presented to the last convention, not considered then because of lack of time, with some minor corrections made. The report in Bulletin No. 48 represents the work of the Committee during the last year. The Committee offers two conclusions for the consideration of the convention, the first being: "Your Committee recommends that the Association adopt the definitions of terms as given in the supplementary report." The second conclusion is: "Your Committee also recommends that the proposed standard specifications for cross-ties be adopted."

The President:—I would like to state, in behalf of the Board of Direction, that there is an apparent departure from the rule laid down for the consideration of these reports which we hope will be condoned by the convention, and that is, that this Committee was kind enough to present its report at a very early stage, and it was allowed to submit a supplementary report on account of its inability to get it all done for the first report. Therefore we decided to consider both as if presented in regular order. What line of action will we take regarding this report on ties?

Mr. W. C. Cushing (Pennsylvania Lines):—I move that the definitions be read and acted upon separately.

(Motion carried.)

The President:—The Secretary will read the definitions as they appear in the report.

The Secretary:—"Definitions.—The definitions of terms, as given on pp. 4 and 17 of Bulletin 43, have been reconsidered, some omitted as unnecessary and others modified. They are reprinted as corrected herewith:

"Checks—Small cracks in the wood due to seasoning."

(There being no objection, the definition was adopted.)

The Secretary:—"Doty Tie—A tie which contains dote or dry-rot."

Mr. Cushing:—I simply ask for information as to whether that is a railroad word, or whether it is one coined by the Committee for this special occasion and in colloquial use—the word "dote?"

Mr. Curtis:—In the discussion of the previous report, Mr. Cushing called attention to the fact that he did not find the word "dote" in Webster's Dictionary. We suggest that he get another dictionary, because he will find it in others. We looked the word up and found it. If it is not there, I think we can afford to make a precedent and put it there.

Mr. Cushing:—The word "doty" is generally accepted, but the word "dote" is what I call particular attention to, as it is not so generally used as the former.

Mr. E. DB. Brown (Lehigh Valley):—In connection with these different titles and definitions, I think the Association should adopt an absolute definition rather than a local name, even if the general definition does not exactly explain or define the situation or the object as understood in certain localities. I think we should adopt an authentic name, not a local name, not only as to the Tie Committee, but with all definitions.

The President:—That brings up the question whether this is a local name. We have a large representation here, and would like to hear from others in the different sections of the country.

Mr. H. G. Kelley (Minneapolis & St. Louis):—This brings to my mind a discussion I heard some years ago, in which one of our foremen took part. He said that he had the utmost reverence for the dictionary, but it was necessary to be acquainted with the language of the shop. Doty is the language of the shop, known all over the Mississippi Valley States. I have heard it from Southern Texas to Northern Minnesota.

Mr. E. C. Brown (Union Railroad):—In our section of the country carpenters and others handling timber and wood frequently use the word "doty." I do not know that I ever heard the word "dote;" that is, in the Pittsburg district.

The President:—The word is akin to the word "dotage," when we speak of an old man. I do not know the root, but that is the way it comes up. It is in common use wherever I have been in this country, and where most of the ties are bought at the present time.

Prof. G. F. Swain (Massachusetts Institute of Technology):—I would like to move that the words "dote or" be stricken out of that definition.

(Motion carried.)

The President:—The vote is now on the definition as amended, which reads as follows: "Doty Tie—A tie which contains dry rot."

(The definition as amended was adopted.)

The Secretary:—"Heart Tie—A tie which shows sap-wood only on the corners, and which sap-wood does not measure more than one inch on lines drawn diagonally across end of tie."

Mr. A. R. Raymer (Pittsburg & Lake Erie):—I move that the word "only" be transposed, making it read, "sap-wood on the corners only," instead of "sap-wood only," etc.

Mr. Duncan MacPherson (Canadian Pacific):—It seems to me there must be some sap-wood on heart-ties, else they would not be heart-ties.

Mr. W. M. Camp (Railway and Engineering Review):—There is a

definition below which covers the kind of tie Mr. MacPherson refers to

(The motion to transpose the word "only" and place it after the word "corners" was adopted.)

Mr. F. H. McGuigan (Grand Trunk):—I would move that the word "and" after the word "corners," and the words "sap-wood" after the word "which" be stricken out.

The President:—The definition would then read: "Heart Tie—A tie which shows sap-wood on the corners only, which does not measure more than one inch on lines drawn diagonally across the end of tie."

(Motion carried.)

The President:—The question is now on the original definition.

(The definition as amended was adopted.)

The President:—The next definition is that of a "Pecky Tie."

Mr. Walter G. Berg (Lehigh Valley):—I move that the matter in parenthesis be left out.

The President:—The Committee does not recommend that the Association shall adopt that.

Mr. Berg:—I withdraw the motion.

Mr. Curtis:—There is a question in my mind whether that should go in there properly, but at the same time, in preparing these definitions, we had quite a discussion over the definition of pecky ties—as to what caused it, and sundry matters connected with it, and that matter drifted in. Since Mr. Berg has brought up the question, I do not know but that his suggestion is one which, for the present time, ought to be adopted. Probably it would be better, having been brought to the attention of the convention, to strike that out of the definition, so that in the republication of the report it will not appear.

Mr. Berg:—I think it is a well-known rule with the people having the publication in hand that if matter is in parenthesis like that it is not to be printed. This does not need a motion.

The President:—I can assure you that it will be left out, if it is perfectly understood. The question is on the definition of "pecky tie." Are you ready for the question?

(The definition was adopted.)

The President:—The next definition is "Pole Tie." Any discussion on that definition?

Mr. Cushing:—It does not seem to me that that is exactly a definition. It might be an explanation, but it is not a definition, because there is also a tie known as slab tie, made in precisely the same way, only that it is sawed instead of being hewed. There is a distinction between the two —at least so far as my practice is concerned—and I would think that should be modified so as to be a little more explicit.

The President:—Will the gentleman suggest his modification?

Mr. Cushing:—If after the definition was voted on, it were voted down, I would have proposed what I have already proposed in a written discussion printed in Bulletin 43, that is, "Pole Tie—A tie hewed on top and bottom and left rounded on the two sides. Not more than one tie can be made from a section of a tree." That becomes a slab

tie, sawed and not hewed, according to our specifications for the making of such ties.

Mr. Curtis:—That matter was fully discussed by the Committee in the light of Mr. Cushing's suggested change on the previous report, and it was voted not to accept the amendment Mr. Cushing had suggested. A pole tie means something definite. It is a tie made from a tree that will make but one tie. In some parts of the country they make a slab tie from it, but in other parts it is a pole tie, whether you saw it or hew it. But we also put in the definition of "slab tie," conforming it to Mr. Cushing's suggestion. It seems to me the definition the Committee has given it is clear in so far as those two names are concerned, and that there is a material difference there which it would not be well to confuse by the adoption of the suggestion made by Mr. Cushing. "Pole tie," it seems to me, is the generally accepted definition of the term. A pole tie is a tie made from a tree only large enough to make one tie.

Mr. Camp:—I agree with Mr. Cushing as to the definition of a pole tie, but not as to the definition of a slab tie. My understanding of a pole tie is a tie cut from a tree that will make only one tie, left rounded on the side, no matter whether sawed or hewed. A slab tie is different—a tie cut from a log, out of the sap part of the log, cut from a large strip of timber.

Mr. Curtis:—You agree with the Committee instead of with Mr. Cushing.

Mr. Camp:—No, sir; I believe the pole tie should be left rounded on the side, no matter how it is cut, whether sawed or hewed.

The President:—That is the definition of the Committee.

Mr. Camp:—Not exactly. They make no mention of leaving the tie rounded on the side. It is made of a tree of such and such size, and no more than one tie can be made from a section. It might be sawed or hewed on all sides, according to this definition.

Mr. McGuigan:—In order to expedite the work of the convention, I would move that the definition be amended to read: "A tie sawed or hewed from a tree of such size that not more than one tie can be made from a section," and eliminate the words "slab tie."

Mr. A. S. Baldwin (Illinois Central):—If you talk to a practical timber man, he will always refer to a single tie made from a tree as a "pole tie," I care not whether it is hewed on the four sides or not; to him it is a "pole tie." If two edges are cut from a tree, he calls it a "half tie;" if three edges, a "quarter tie;" all can be hewed exactly the same dimensions in the end, but those are the definitions, so far as my experience goes, in Kentucky, Tennessee, and that part of the country, as to what constitutes a "pole tie." A "pole tie" may be rounded or hewed on the side.

Mr. W. F. Tye (Canadian Pacific):—My understanding of "pole tie" is one sawed or hewed on two sides only, and I would like to ask the Committee if they considered a tie a "pole" tie even if it were sawed on four sides.

Mr. Curtis:—Yes, sir; if the tree from which it was made was only large enough to make one tie.

Mr. Cushing:—It seems to me the point we are now discussing is one of the important works of the Association, and especially of the Committee on Ties, and that is the introduction of Cross-Tie Specifications. This is a point I have had in mind for a long time as being one of the important features of our work in this Association, and the preliminary discussion so far has indicated exactly what has been found to be the trouble with railroad companies in purchasing ties. There is a misunderstanding in the use of terms, and naturally each company has attempted—as it found difficulty in this matter—to make its own corrections. There is with us a distinct difference between a tie rounded on two sides, and whether hewn or cut with a saw on the other two. Some railroads have even gone so far as to claim a less length of life for a tie which is sawn. I do not share the same view, in speaking of the discussion as at present, but I feel there is a necessity for distinction; and while it is quite true we cannot make cross-tie specifications which will come up to the individual requirements of all companies, yet I feel there is an opportunity to make a specification which can be regarded as something we should come to by degrees. We are all going more or less to the same country to purchase ties, and we find that the companies which go to these districts for ties have a great variety of specifications, and the result is, it is difficult for some companies to obtain the character of ties which they desire. I have heard a great deal of gossip in regard to the inspectors' trials and tribulations in the various countries. One of the troubles they run up against is that certain ties are cut by a large tie-supply firm, and one railroad company comes down and picks out what will fit its specifications, and another company will come down and pick out what the other one has left behind, and such stories as that.

I think a good work can be performed by the Association in obtaining or laying down specifications which will fit us all more nearly, and be considered as a marketable specification. For instance, a 6 in. by 8 in. by 8 ft. sawed tie is regarded in the Chicago market as a "standard tie." Many roads use it, but many roads do not. But there is the tie, and if you want it very badly, you will have to take it. Now, it is in the matter of specifications of that kind that I think we can do good work; and I think it is necessary, also, on the start, to understand what each company means in the use of these terms. I feel that the specification of the Committee is a little too general in regard to the "pole tie." It may be all that Mr. Curtis says, as a general specification, but if it is possible for us to make the definitions a little clearer and more distinct, I cannot see any objection to doing so. If it is the sense of the Association that it wants these definitions as offered, very well and good, but I think we ought to understand fully, before we vote on these points, just exactly what we do want. A "pole tie" can be either one with a rectangular cross-section or one with two parallel faces and two rounded sides, according to this definition. We know very well that a pole tie with rounded sides is superior to one with a square cross-section. If there is a difference in value between these two ties, why not have it understood, and then we will know what we are purchasing when we

make a specification. These specifications which different companies put out go to the same district and lead to confusion in that district in the cutting of the ties; and I would like to see something more uniform, even if I find it necessary to give way so far as my individual ideas are concerned.

The President:—The question is now on the amendment of Mr. McGuigan.

Mr. McGuigan:—I would say that I simply substitute the words "sawn or hewn" for the word "made," the definition otherwise to remain as it is.

Mr. C. S. Churchill (Norfolk & Western):—It seems to me that the Committee's definition covers the case. The use of the word "made" shows that it can be made either by sawing or hewing. I think the trouble we are in arises from the fact that there are some definitions we should have but which have been omitted. My suggestion is, that we leave that definition as it stands, and then if we add a definition for a "hewn tie—one hewed on at least two sides"—we get a description of the ordinary way of cutting ties as they are hewn in the woods; further down we have a definition of a slab tie. If we had also a definition of a "sawed tie—a tie sawed on four sides"—it seems to me we get out of our difficulty, and the definition submitted by the Committee would stand as presented. I think the definition is correct as given for a pole tie, and there are two other ties which are subdivisions, which are mentioned in these definitions. I disagree with the amendment for the reasons given, and later on would offer additional definitions to cover the point in question.

(The amendment was put to vote but was not adopted.)

The President:—The question is now on the adoption of the original definition for a pole tie.

Mr. Baldwin:—Before going back to the original definition, I think in this case the definition is mixed up with the specification. "Pole tie" is a term used by timber men and refers to a tie made from a tree which is only large enough to supply one tie. You may specify that a pole tie shall be sawn on two sides and hewn on two sides, but a pole tie refers to a definite thing which I believe is covered by the definition given by the Committee. I move the adoption of the definition presented by the Committee.

(Motion carried.)

Mr. J. G. Sullivan (Canadian Pacific):—I would ask the Committee what designation they would give to ties where there were four or more ties cut from the same section.

Mr. Curtis:—I do not think the Committee would necessarily define them except as ties. There are other elements which might define them. Further down in our definition we have "split ties." You might split the ties you refer to out of trees, and they would be split ties, but when you get beyond a tree which will make four ties, in the Committee's judgment, it made no difference, and there is no occasion for a definition therefor. There may be, and is, up to a certain point, some occasion for a distinction between the tie made from a tree which will make one tie,

and ties from trees which will make two ties, and ties from trees which will make four ties, but beyond that the Committee was unable to see that there was any occasion for defining such things. I want to say, along this line, that we had several other definitions which we had prepared, but the Committee concluded the fewer definitions presented, the better. We avoided defining any words unnecessarily, and eliminated every definition which we had prepared for which there did not seem to be some absolute necessity.

Mr. J. G. Sullivan:—Would there be an objection, then, to changing that definition to read: "A tie made from a tree of such size that four or more ties can be cut from one section?"

Mr. Curtis:—The only objection is that it would be a verbal contradiction; it would not be a quartered tie if six ties were made from the one tree. That is the only objection.

Mr. Camp:—The definition is incomplete. It merely states the size of the tree, and does not state in what manner the tree is cut up. According to the definition as it now stands, two ties made from a section of a tree might be quartered ties, as the definition says that the section of the tree must not make more than four ties.

Mr. Curtis:—I think the necessity is to consider why there is any occasion for definitions of this kind. If you have a tree so small that you can make nothing but a pole tie from it, you are making use of the entire tree, except such parts as are hewn or sawed off. If you have a tree which makes two ties to the tree, then, of necessity, one-half of the tie is heart-wood and the other half of the tie represents outer growth. Take a quartered tie, and, of necessity, one part of the tie is heart-wood and the other outer growth. Referring to Mr. Camp's suggestion, I think his objection loses its point when you consider that there are these elemental features about these other kinds of ties.

Mr. Camp:—Suppose you made two ties out of a section instead of four, what would they be?

Mr. Curtis:—Do you predicate the question on the fact that the section of the tree would make four ties?

Mr. Camp:—The section of the tree might be large enough to make four ties, but still, for the sake of argument, be cut into two. As long as the definition admits of the possibility, but is intended not to cover such a possibility, it is, in a sense, ambiguous.

Mr. Curtis:—That is all right. We are not attempting to get definitions which some professor cannot pick flaws in. We are trying to get working definitions. We might take a tree which would make four ties, and someone may cut only two ties out of the tree and waste the other half of the tree, or do something else with it, but I do not think that is a practicable condition which we need to consider. If they should do this, then there are still the same elements in these two ties that we would find in the ties if four ties instead of two were made from the tree.

Mr. Camp:—The definition does not state definitely four ties; it says not more than four ties. Such would be construed to mean any number less than four.

Mr. Cushing:—I think Mr. Camp has stated the gist of this matter. It seems to me the definitions of the Committee are all on a wrong basis. They are on the basis of how many ties one can get out of a tree, and if any railroads make specifications for their ties in that way, I am not acquainted with them. None of the specifications I have ever seen defines a tie or specifies the number of ties which can be cut from a tree. It is the manner of making the tie which interests the railroad companies, and I think that should be the basis for our definitions.

Mr. J. G. Sullivan:—I think that Mr. Cushing is wrong in his conclusions. It seems to me that the Committee's definitions here are very good. There are two points: One is the quality of the tie—the material of which it is composed, and the other is its characteristics as to shape and size. One man may have in mind the quality when he is describing a given tie, and another man may have in mind the shape. You can fix the shape in your specifications. I think the Committee is right when it looks at the quality. For instance, a pole tie is one made from a tree of such size that but one tie can be made from a section and you get a certain quality of timber regardless of the shape of the tie. The point I want to make is, if a company decides that it should have "quartered ties," and specifies "quartered ties," would it not expect ties that were cut out of trees which would make more than four ties out of a section? Therefore, it appears to me, if these are the lines the Committee had in mind, they have presented the matter in the proper way. If that is the case, I fail yet to see why the Committee would not accept ties as "quartered ties" where there were more than four coming from a tree.

Mr. Curtis:—Is it not true, if you get more than four ties from a tree you would get certain ties which were all heart? We have defined "heart ties." You can say, if you please, that these ties shall be "quartered ties" and "heart ties." We do not want to encumber these definitions with a lot of terms to try to cover every possible and even improbable contingency. If we can get practicable working definitions, correct so far as they go, I think that is the point to which we ought to work.

Mr. J. G. Sullivan:—You will get some "heart ties." Take a tree three or four feet in diameter, and it seems to me you are leaving a loophole for some inspector to make a mistake. The inspector will go out and find ties which do not show all heart. He would not take them as quartered. If they should show on one quarter a little sap, I do not see how he is going to accept the tie. He will be at a loss to know what you will call it; it is not a "pole tie," a "quartered tie" or a "heart tie."

Mr. Curtis:—Why is it not a "heart tie" if it shows a small portion of sap on one corner?

Mr. John V. Hanna (St. Louis & San Francisco):—It seems to me that the definition can be made perfectly clear by saying that it is a tie made from a tree of such size that four ties are made from a section. The term "quartered" indicates that four ties are made from a tree, and if you say four ties are made from a section it eliminates the question of possibility of misunderstanding and gets down to what is actually done.

I move that the definition read: "A tie made from a tree of such size that four ties are made from a section."

(The amendment was adopted.)

The President:—The question is on the original definition as amended.

Mr. Curtis:—I want to object to the definition as given, unless the word "only" is inserted. Do not let us go from one extreme to another and make a definition which is incorrect. Suppose you make it from the section, you still make four ties, but it is not a quartered tie. Put the word "only" there and it means what you intend.

The President:—The amendment has been adopted, and if some gentleman who voted in the affirmative will move to reconsider it, we will take this question up.

(On motion, the action of approval was reconsidered.)

Mr. Kelley:—I offer an amendment to the definition of the "quartered tie," that the words "can be" shall be stricken out and the word "are" be substituted in their place. The definition will then read: "A tie made from a tree of such size that four ties only are made from a section."

Mr. Curtis:—The Committee accepts that amendment.

(The definition as amended was adopted.)

The President:—The next definition is "Sap Tie—A tie which shows more than a prescribed amount of sap-wood in cross-section." What action will you take on this definition? Without objection, we will consider the definition adopted. The Secretary will read the next definition.

The Secretary:—"Shakes—A separation of the wood fibers, due to the action of the wind."

(No objection being made, the definition was adopted.)

The Secretary:—"Slabbed Tie—A tie sawn on top and bottom only."

Mr. Churchill:—I ask if the word "slabbed" is one that is generally used. I do not know whether it is correct or not, but we use the word "slab."

Mr. Curtis:—The Southern members of the Committee were not familiar wih the term "slabbed tie," but realized that there was a "slab-tie." If in the knowledge of the convention the term "slabbed tie" is in general use, it would be desirable to use it as we give it.

Mr. Tye:—The Committee in this case departs from the rules which it has heretofore followed. Heretofore, it has simply described the ties as to size of tree, without describing how the ties are to be made.

Mr. MacPherson:—Is the tie sawn or hewed?

Mr. Curtis:—The understanding is that a "slabbed tie" is a tie from which a slab has been taken off. If hewn, it is not a "slabbed tie;" but a piece taken off by a saw is a slab.

Mr. G. A. Mountain (Canada Atlantic):—In Bulletin 43 the same word is used by the Committee, but there it is stated to be a tie sawn or hewn on the bottom only.

Mr. Curtis:—The Committee defined "slabbed tie" in that way, but concluded that it was not justified, and consequently the word "hewn" was eliminated.

Mr. MacPherson:—That will require another definition.

Mr. Curtis:—If you want to define a tie as distinguished from a tie made from a single tree, hewn on top or bottom only, it requires another definition. But if the convention adopts the specification which the Committee offers, a great many of these terms will be valueless because they are not used.

Mr. Kelley:—Speaking of a "slabbed tie," I happen to have my inspector of material present, who has inspected ties and other material for many years, and I put the question to him as to what he understood by a "slabbed tie." His reply agrees precisely with that of Mr. Baldwin, that it is a tie sawn on top and bottom face, and then, because the tie is too wide or ill-shaped, slabbed off on one edge, leaving a tie which is sawn on three sides. It is never hewn. It is slabbed in the mill. So that the definition offered by the Committee would not distinguish the tie that is known in the woods by that name. A "slabbed tie" always has one edge round, uncut.

Mr. Baldwin:—I think Mr. Kelley is correct. A "slabbed tie" gets its name from what is called "slabbing" at the mill. A "slab" is what is sawed off at first from the round log. That is tossed to one side, and if it can be split up and made into ties, it is so used. I have seen ties sawed on top and both sides, with a round bottom, which we called a "slab-tie." I have also seen them sawn on top and one side and round on the other. The essential idea of a "slab-tie" is that it is made from what is called a "slab" at the mill. That is where it gets its name.

Mr. E. C. Brown:—Evidently in the two sections of the country there are two different ties that are being indiscriminately called by the same name. The Committee has chosen the name "slabbed" as being the tie which we have in the East, but here in the West, where they have larger trees, they undoubtedly occasionally make a tie from a slab, so that it seems to me they are two different things.

The President:—Like the tariff, it is a local question; but I think the Committee, as a general thing, has tried to follow the terms that they found in use in different localities.

Mr. H. J. Slifer (Chicago, Rock Island & Pacific):—It has been aptly said by one of the preceding speakers that these definitions should apply to quality. I do not know that that has anything to do with the question whether a tie is a "hewn tie" or a "sawed tie." It seems to me the question of the definition of a "slabbed tie" is more a question of manufacture than of the quality of the tie. I move that we strike out the definition of "slabbed tie."

(On a rising vote, the motion was lost.)

Mr. Camp:—I agree with Mr. Kelley and Mr. Baldwin. I think I gave the same idea when I spoke in regard to the "pole tie," that is, a "slab-tie" is made from the slab part of the log coming from a large mill—material which otherwise goes to waste.

Mr. Tye:—I ask the Committee if a "slab-tie" is defined, why should not a "pole tie" be defined?

Mr. Curtis:—It is; no question about that. We do not necessarily make these definitions so one will not include another. We try to make

them correct, but if one definition describes some other tie, that is all right.

The President:—It is generally understood in my country that "pole ties" are either sawn or hewn.

Mr. Raymer:—I object to the motion as made, because it confuses the two ties—one made from the slab and the other made by the fact that the slab is taken off. I think the definition made by the Committee of a "slabbed tie" is a "pole tie" sawn. The motion will simply reverse the trouble and transfer it to the tie which is commonly called a slab tie.

Mr. Hanna:—As a matter of fact, is the word "slabbed tie," as we have it here, in use? Is there any occasion to use or define such a word? Do the tiemen know of such a tie as is here mentioned? If they do not, the word we should define is the one that is generally used, and that is the word "slab tie."

Mr. E. C. Brown:—The intention is understood. It is probable that the tiemen have gotten into the habit of pronouncing the word short and making one syllable of it. Strictly speaking, it is a "pole tie" sawed on two, and sometimes three, sides, and it seems to me there should be two definitions describing the two articles.

Mr. Baldwin:—This discussion brings out the fact that there are two terms, very much alike, referring to different kinds of ties, one tie made from a slab and the other tie made by slabbing off. I think the suggestion to have two definitions is a good one. I think there should be two definitions to cover these two kinds of ties. I move that the definition as given for a "slabbed tie" by the Committee be adopted, and an additional definition be given for a "slab tie—a tie made from slabs." I think it is necessary to have two definitions, although the words are very nearly alike.

The President:—It is necessary for us to have the definition as it now stands to describe a "slabbed tie," made by taking slabs from the timber, and under the suggestions made by Mr. Baldwin, it will be necessary to have a definition describing a tie made from a slab of timber. If there is no further discussion on the question, Mr. Baldwin's motion will be put to vote.

(The motion was carried.)

The President:—The Secretary will read the next definition.

The Secretary:—"Split Tie—A tie made from a tree of such size that two or more ties can be made from a section."

Mr. J. G. Sullivan:—Does that mean that the tie can be either sawn or split and be called a split tie?

Mr. Curtis:—Either sawn, or hewed, or split.

Mr. Camp:—Then I object to that definition. My understanding of a "split tie" is that it is one split out by beetle and wedge, or by some similar process, and hewn enough to square it up. A tie sawn out would not be a "split tie."

Mr. Kelley:—This is a definition which refers particularly to the method of manufacture. Now, the question arose with one gentleman here as to whether this would mean what is known in the South as a "half-tie." But a "half-tie" may be hewn or split, and the term "split," referring to manufacture, would mean any tie that was manufactured from the tree by

the method of splitting, and not by sawing. In splitting the ties, we refer to the method of manufacture, the process by which the tie is made, and I would therefore offer this amendment, by inserting after the word "made" the words "by splitting," so that the definition will read, "A tie made by splitting from a tree of such size that two or more ties can be made from a section."

Mr. Tye:—I would ask Mr. Kelley what he means by "splitting?" Can you not split with a saw, as well as with an axe or wedges?

Mr. Kelley:—I do not think a carpenter would call it that. If he wanted to saw with the grain of a piece of wood he would use a ripsaw; if he wanted to split it he would use a wedge.

Mr. Curtis:—The Committee considers this a distinction hardly worth while to make. We do not care whether they cut the tie in two pieces by wedges or in some other way. If in the mind of the convention there is a difference, the definition should be amended.

Mr. J. A. Atwood (Pittsburg & Lake Erie):—I would suggest that we employ the word which will best express what we mean, and use the word "halved." We use "quartered" above, and why not use "halved," and not call it split?

Mr. MacPherson:—The Committee is not consistent, because in one place they say a "slabbed tie" cannot be made by splitting, and in the other they say a "split tie" can be made by sawing.

Mr. C. A. Wilson (Cincinnati, Hamilton & Dayton):—I think the Committee got into that trouble by trying to define the way they are made. There are three ways—sawing, splitting and hewing. It seems to me if we want to have a split tie, we should not describe a tie which can be made by sawing. That is not what we want. We get the term largely from manufacturers.

The President:—The question is on the amendment of Mr. Kelley, that a split tie shall be "A tie made by splitting from a tree of such size that two or more ties can be made from a section."

(The amendment was adopted.)

The President:—The Secretary will read the next definition.

The Secretary:—"Strict Heart Tie—A tie which shows no sap-wood in cross-section."

Mr. Hanna:—I should think that with strict heart tie we might leave off the words "in cross-section." I move that these words be omitted.

(Motion carried.)

Mr. J. G. Sullivan:—I move that the word "contains" be used instead of "shows."

Mr. E. C. Brown:—If you change the form of the definition, I think "A tie having no sap-wood" would be better.

(Mr. Brown's motion was adopted.)

The Secretary:—"Tapped Tie—A tie made from a tree the resin or turpentine of which has been extracted before felling."

The President:—If there is no discussion, we will consider that definition adopted.

The Secretary:—"Tie-plate—Something interposed between the rail and the tie to prevent wear of the tie."

Mr. Tye:—I hardly think that definition pertains to the Committee on Ties. Does it not apply to the Committee on Track or Roadway?

Mr. Robert Trimble (Pennsylvania Lines):—I move that it be eliminated from the definitions.

The President:—It is hardly necessary to put a vote on that motion, as the term is not used in the committee report. It will be understood that this definition is not adopted in connection with the report of the Committee on Ties.

The Secretary:—"Wane Tie—A squared tie showing part of the original surface of the tree on one or more corners."

Mr. Hanna:—May not the "original surface" mean the bark? Do you mean showing the bark?

Mr. Curtis:—I have seen "wane ties" showing the bark.

Mr. Hanna:—I would like to know what the Committee means by "original surface."

Mr. Curtis:—The present member of the Committee admits his inability to express the idea in this definition. It is sometimes difficult to define what you have in mind.

Mr. Atwood:—I move that the definition be adopted as presented.

(Motion carried.)

Mr. E. C. Brown:—Referring to the definition of "Shakes," I recall that we passed that without objection. There is a confusion of the plural and singular in the definition.

The President:—That could be remedied by striking out the "s" in the word "fibers." If there is no objection, that will be done.

Mr. Churchill:—I would like to ask the Committee to add a definition which I think will make these definitions clearer, because a lack of certain definitions has brought forth a good deal of this discussion. I would like a definition added relating to a hewn tie, as follows: "Hewn Tie—A tie hewed on at least two sides."

(Motion put and carried.)

Mr. Wilson:—I think we should have a definition of sawed tie. We have all the rest. I suggest "Sawed Tie—A tie sawed on two or more sides."

Mr. Churchill:—Perhaps there is a difference in the practice in different sections of the country. As far as my knowledge goes, the most common way to produce a sawed tie is to saw it on all four sides. That shows where the difference in "slab ties," or "slabbed sawed ties" comes in—"slabbed sawed" meaning a tie from which two slabs have been sawed; whereas the "sawed tie" used on bridges or in the track is one sawed on four sides. I offer that as an amendment, that a "sawed tie" be a tie sawed on four different sides.

Mr. Wilson:—I accept the substitute.

Mr. Mountain:—We have "sawn ties" sawed only on two sides. Our road uses nothing but "sawn ties" sawed only on two sides.

The President:—One definition necessarily embraces the other. A "sawn tie" is one gotten out with a saw.

Mr. Mountain:—The amendment just suggested and accepted says they must be ties sawn on all four sides.

Mr. Hanna:—I do not believe we need a definition of the sawn tie. The word is so perfectly understood that there is no occasion and no opportunity for misunderstanding it. I think we should vote the motion down, and if the motion adopting a definition of a "hewn tie" was passed, we should reconsider that and leave them both out.

Mr. Berg:—I agree with what Mr. Churchill says, that there is uncertainty when you speak of a "sawn tie"—uncertainty whether you mean a tie sawn on two or four sides. If an order was given for ties for a bridge and you wanted all four sides sawn, and the ties were delivered sawn on only two sides, there would be a good deal of trouble about it.

Mr. MacPherson:—I think Mr. Hanna is right, that it is not necessary to define "sawn" or "hewn ties." What is the use of putting either of them in? They explain themselves.

Mr. Atwood:—We use the words "sawn ties" right along, and mean ties sawn on four sides—not "slab-ties," which are ties sawn on two sides. When we use the expression "sawn ties," we do not want to convey the idea of "slab-ties," but ties sawn on four sides. I think we should adopt the definition.

Mr. Wilson:—Those of us who have any correspondence on the question use the term "sawed ties" more frequently than any other. That is my reason for trying to get a definition of "sawed tie."

The President:—The question now is on the adoption of the definition of "sawed tie," to mean a tie sawed on all four sides.

(The definition was adopted.)

Mr. Baldwin:—We are short of one definition. We have the "pole tie," quartered tie and other ties, but not the "half tie." When two ties come from a tree, tie men call them "half ties." I move an additional definition: "Half Tie—A tie made from a tree of such size that two ties only can be made from a section."

(The definition was adopted.)

Mr. W. S. Kinnear (Michigan Central):—I move that the Committee be instructed to furnish a definition of the word "tie," to be placed at the head of the list.

(The motion was carried.)

Mr. V. K. Hendricks (Baltimore & Ohio):—It will be necessary either to reconsider the definition of a "pole tie," or to make a definition of the same tie which is hewed or sawed on two faces only. In the report "pole ties" are referred to as having two faces, meaning a tie which is rounded on two sides. I move that the definition of "pole tie" be reconsidered, as it is necessary to give a description of the "pole tie" in each of the two places in the report where it is referred to. Mr. Baldwin said a "pole tie" might be square. The language used in the report, referring to "pole ties," is as follows: "Except in pole ties, none shall be less than 8-in. face, and in no tie shall the thickness be less than 6 in. A variation in size will be permitted of ½ in. over in thickness, 2 in. over in width, and 1 in. over in length." The next clause reads: "In pole ties the face may be less than that given in the table of dimensions below, but the least area in cross-section shall be not less than the area

corresponding to the tabular dimensions, and in no case shall the face be less than 6 in."

(The motion to reconsider was not carried.)

The President:—We will next consider the specifications. The first clause of the specifications is before the convention for action, being the clause providing for the kinds of woods that are recommended to be used without preservative treatment. In a written discussion presented, the addition of cherry and mulberry is suggested. Is there any discussion on that clause of the specifications?

Mr. Churchill:—I think we might add chestnut oak as a member of the white oak family.

Mr. Curtis:—I think there is no question about the definition of the white oak family. All of the oaks which have a rounded lobe belong to the white oak family. Any of them which have a pin-pointed lobe are red oaks. That is well recognized, and I think is beyond any question a positive determination of the two families; and the chestnut comes under the white oak family.

Mr. Churchill:—Would a tie contractor understand that?

Mr. Curtis:—My judgment is that he would.

The President:—It is not a question of a tie contractor. In this instance the question is, shall we recommend the use of these ties without treatment?

Mr. Curtis:—I would like to ask if the members can give any information on the locust. As the specification is written, we specified the honey locust. That was criticised by several gentlemen to whom it was submitted as being incorrect; that the honey locust was worthless as a tie, while the black locust was the material that should be used. We were unable in the time left us when the question came up to determine the point, so we cut the knot by cutting out the adjective, leaving it "locust." If the members can give any information as to the relative value of the honey locust and black locust, I think it would be perfectly proper to qualify that word. I might also say that there were other woods—one of those mentioned in the discussion of Mr. Hendricks, wild cherry—which were recognized as being good tie timber, judging from the specifications we have, but they were in such slight use we thought best to eliminate them from the list. We did not try to put in every kind of tie that any road had ever used.

The President:—Has anyone any remarks to make on the question whether we should qualify the word "locust" in the specification? I have no personal knowledge of the life of the honey locust, but its reputation in my section of the country is that it is a very poor timber, while that of the black locust is that it is very desirable. If there is no further discussion on the kinds of woods recommended for use without preservatives, we will consider the section adopted and pass to the next. It reads as follows: "The following woods shall not be used for tie timber without a preservative treatment approved by the purchaser: Red oak family, beech, elm, maple, gum, loblolly—short leaf, Western yellow pine, Norway pine, North Carolina pine and other sap pines, red fir, spruce, hemlock, tamarack." Mr. Hendricks, in his written discussion,

suggests that as some railroad companies treat their own ties, the paragraph between the list of treated and untreated ties be made to read as follows: "The following woods shall not be used for tie timber without a preservative treatment approved by the purchaser, but may be purchased untreated under special contract."

Mr. Curtis:—It consists in the addition of the words, "but may be purchased untreated under special contract." I would like to say that there was considerable discussion in the Committee. We attempted to draw the line between specification and contract. There were certain things it seemed should be left to the contract, and we thought we should not attempt to draw the specification and the contract together. It seems to me that would be covered more properly by the contract than by the specification.

Mr. Churchill:—As it is often necessary in quick construction to take ties below standard, even though they may not last more than four or five years, there should be a modification to the clause recognizing such a condition. I move the insertion of the word "preferably," making the clause read: "The following woods shall preferably not be used for tie timber without a preservative treatment," etc.

The President:—The Committee accepts that. We will pass to the next clause. The Secretary will read it.

The Secretary:—"All ties must be well and smoothly hewed or sawed out of sound, straight timber, sawed ends, and must be of specified dimensions, with straight and parallel faces, the minimum width of either face to be not less than that given in the table of dimensions. All ties must have bark entirely removed. Ties shall be free from splits, shakes, loose or decayed knots or any other imperfections which may impair their strength or durability."

Mr. Curtis:—Mr. Slifer requested me to call attention to a change or clause which he thought should be inserted. After "all ties must have bark entirely removed," insert "before being delivered on the company's ground." I think myself that is a change that ought to be made. As I am the only member of the Committee present, I would rather have the convention make the change than do it myself. Mr. Slifer's position is that the roads have a great deal of trouble at times with ties delivered without the bark being removed, resulting in encumbering the grounds by cleaning them on the right of way, making a general nuisance of the matter, which he proposed to eliminate by compelling the tie contractors to remove the bark before delivery on the right of way.

Mr. Kelley:—This reads: "All ties must be well and smoothly hewed or sawed out of sound, straight timber." That will admit dead timber, which we do not wish to admit. Referring to the specifications in use on the Minneapolis & St. Louis Railway, they read: "All ties must be cut from sound, straight, growing timber;" in other words, "live timber." Then it would appear that the Committee would practically obtain the same material. Skipping the items which refer to size, the Minneapolis & St. Louis specifications continue: "They shall have parallel faces out of wind." This specification does not specify parallel faces, or

that the tie shall be out of wind, both of which I think are important requisites in obtaining good ties.

Mr. Curtis:—The specifications say, "straight and parallel faces." They can not be straight if they are in wind.

Mr. Kelley:—I am not so sure of that. Take out that one point—straight timber, out of wind—the tie may be in wind and the timber may be straight.

Mr. Curtis:—What is your definition of "wind," Mr. Kelley?

Mr. Kelley:—Warped surface.

Mr. Curtis:—If the tie is straight, it has not a warped surface, has it?

Mr. Kelley:—Possibly not; yet I believe the specifications would be less open to objection if that item is put in, and I do believe that we should insert "growing timber," and not open the field to the admission of dead timber, which is frequently run in with ties.

Mr. Curtis:—On the question of live timber, there was a good deal of discussion in the Committee. I believe the difficulty is caused by a misconception as to what live timber is. A great many specifications which we examined had that clause in them. As a matter of fact, your timber is not living, and never is, except in the immediate growing surface. The rest of that timber is as dead as though it were in this floor. What is the use, under such circumstances, of specifying that the timber shall be "live?" If the tree has been dead for any length of time and growth stopped, your timber is still all right and perfectly sound, unless there has been a fungus growth started in it, in which case the timber is not sound and does not comply with the specifications. That matter was thrashed over thoroughly in the Committee, and it reached the conclusion that it would be best to take the bull by the horns and ask the Association to place themselves in accordance with the facts and eliminate the term "live," which, as a matter of fact, has not any bearing whatever, so far as I can learn, on the subject. Your timber, out of which your ties are made, is not live timber; it is dead, and in a large tree has been dead 150 years, and that is the very stuff you would rather have, if you can get it. What is the use of specifying ties shall be cut from "live" trees? We do say it shall be "sound," and that is all we care about.

Mr. Kelley:—I would ask the convention for information, whether in their experience with the use of timber known to be dead they find as strong a tree, as strong a tie, as one cut from growing timber? I used the word "growing," not live. My own experience is that the tie which was known to be dead, and which nevertheless did not present any fungus growth that could be detected by the eye, was brash, and lacked the strength that a tie cut out of the same wood from a growing tree would be found to have.

The President:—If Mr. W. K. Hatt is in the room, we would like to have him take part in this discussion, especially on the question of whether the heart is dead or not.

Professor W. K. Hatt (Purdue University):—I think the principle that governs such a matter is that the engineer should be concerned rather

with the material as received than with its probable source. The specifications as written should cover the character of the material desired.

In the specifications for ties and other structural timber, there are a great many clauses that have descended from one specification to another without any basis of reason for their existence. A common specification is, for instance, that timber shall be from unbled pine. Now, we know that the process of bleeding a tree does not affect the heart at all, and that the effect on the sapwood in the neighborhood of the wound is to bring more resin to that particular spot. The disadvantage to the tree is that its growth and development are interfered with, but the quality of the wood of the tree is not affected by the process of bleeding in itself. Furthermore, no inspector can tell from the appearance of the stick of timber whether it is from a bled tree or not, unless the mark of the wound is seen, or the presence of the translucent wood, due to the excessive amount of resin, discloses the effect of bleeding. The evil effects of bleeding lie in the reduction of the diameter of the trunk by excessive boxing and the subsequent overthrow of the tree by wind, and also in the fires that start at the resin in the boxes. The presence of the wound also gives entrance to insects and other agencies which kill the tree. At any rate, any defects are guarded against in the general specifications for quality, and there is neither reason nor use in the inclusion of such a specification that the timber shall be from unbled pine. As a matter of fact, there is very little long-leaf pine now standing that has not been bled.

What is true of a specification with regard to the use of bled pine is also true of the specification with regard to the use of live timber. The heart of a living tree is dead from a botanical standpoint. The cells do not any longer share in the life processes of the tree. The tree will live and flourish with the heart removed from the trunk. Of course, it might be blown down by the wind. So that the very kind of timber which the engineer desires, that is to say, heart timber, is dead timber—as dead as a wooden leg.

To take the case of dead trees. If, subsequent to the killing of timber by fire, or other unnatural cause, the tree is blown down, and the trunk lies on the ground until it becomes acted upon by the agencies of decay, then the action of these agencies will be evident in the timber as supplied. Timber of first quality, however, may be obtained from dead trees, or from trees which have been lying on the ground. Sound logs of red fir and redwood may be seen lying on the ground in the Western forests, with trees four and five hundred years old growing thereon. Would anyone reject a redwood tie because it had been cut from such logs?

I think it may be easily shown that, if the use of timber from standing dead trees, or of sound fallen timber, is successfully shut out by the adoption of a specification, a higher price will have to be paid for the material obtained. Now, if material of as good quality can be obtained at a lower price by the modification of the specifications, it seems worth while to omit the clause requiring that ties shall be from live timber. The other fact is that the clause as read has little meaning. If the engineer wishes to shut out ties cut from timber which is lying on the

ground, then the best form of the specification would read, "Ties should be cut from the stump."

Mr. Camp:—I think the Committee's term—"sound timber"—is sufficiently strong. There is much timber killed by fire which remains in sound condition several months. It is satisfactory for every purpose. And then saw logs frequently lie in water months at a time, and the water seasoning is supposed to improve the quality of the timber. The ties may in any case not be cut up until some time after the timber has been cut off of the stump. I think "sound timber" covers it sufficiently well.

The President:—The question is on the adoption of the clause as it appears in the report.

Mr. Curtis:—I do not want to speak for the Committee in that regard. I want the suggestion of Mr. Slifer brought before the convention, and have the convention act upon it, and for that purpose I will make a motion that the report be amended by inserting after "All ties must have bark entirely removed," the words, "before being delivered on the company's ground."

(The motion was carried.)

The President:—The question now is on the clause as amended. Any further discussion?

Mr. Hanna:—I think Mr. Kelley's suggestion, that we ought to say "growing timber" in the specifications, is good. We are interested, of course, ultimately in what we get. As engineers we are interested in the proper way to draw specifications and get what we want. In that we are dealing with men who are not technical men, and the specification has to be submitted to and worked on by various interests. They all understand what we mean when we say "growing timber," and if you open the door for them to use dead timber, I believe it will have a bad result. For that reason it is desirable to have this "growing timber" in our specifications. I believe it should be inserted as a matter of practical value. Also, I think the requirement of their being "out of wind" should be stated. I can easily imagine a tie that would be called "straight" by a man in ordinary conversation that is really "winding." I think that should be stated, and I will make a motion that an amendment be made, inserting the words, "straight growing timber of specified dimensions and out of wind, with straight and parallel faces."

Mr. Curtis:—I want to object to both of those amendments for two reasons. What is the use of putting a clause in your specifications, so far as live timber is concerned, which you can not enforce? Are you going out to examine each one of these trees and find out if they are growing or not? You can not tell when they are made into ties whether the tree was growing or not. What is the use of putting in certain words because it is customary, when it is contrary, or claimed to be contrary, to the facts? And besides that, unless you identify your trees or mark them in some way, you do not know whether you are getting them or not. One member of our Committee spent a great deal of time in the South some years ago, and had occasion to see a great deal of the tie

cutting in the Carolinas and Georgia. Nearly all the specifications of the Eastern roads specify that ties should be cut out from untapped timber. He said he never saw a tie cut from untapped timber. As to the other question, the only fault I have to find with the addition of the words "out of wind" is that it is surplusage and is unnecessary. If the tie is straight and has parallel surfaces, it can not be in wind. If it is so nearly straight that a question arises whether it is straight or in wind, you will take the tie and never say a word, because it is so nearly straight you are glad to get it. What is the use of putting in words which mean nothing?

Mr. Kelley:—I have no desire to appear technical in this discussion. The suggestions I made are born of a great many years' experience in the actual purchase and inspection of the material about which we are talking. I will guarantee that the gentleman who inspects my ties will not miss one out of a thousand. If there is one dead tie out of a thousand which come under his eyes, I will guarantee it will never pass him. I do not mean a tree that is burned or fallen down that season, but in any dead timber that has lain on the ground two, three or more years, we know the results are not as satisfactory as from the growing tree. It may be there is incipient fungus growth, but there is something about that timber, be it oak, cedar or pine, that a competent inspector will never pass. He will know it instantly, and this, as I say, was born of experience that I have had with my specifications. I have tried to make them as simple as I could. I have put that in after endeavoring to avoid it for several years, and then only because the necessity of it was forced upon me. In regard to "out of wind," I do not consider that was important, not as important as the other feature, but I do believe it will insure a better tie when it comes to a question of throwing it out among the culls. A tie may be ordinarily straight in one way, through the center or longitudinally; it may be fairly straight and may be in wind at the same time, and that was added to my specifications after some years of trouble getting timber and ties I wanted, and it gave the inspector one feature that enabled him to throw out a defective tie. I do not think the words are unnecessary or redundant.

Mr. A. S. Markley (Chicago & Eastern Illinois):—What Mr. Kelley has said is certainly true. A man versed in timber and experienced in taking up or inspecting timber can at a glance tell whether it is dead or alive. The addition of the word "growing" removes all doubt of what character of timber is to be taken. Without that word a man can put in dead timber and at the same time be justified in doing so; yet we know that what is termed "dead timber," as Mr. Kelley has said, has been lying on the ground two or three years, and will not last as long as timber cut and used immediately. So far as timber being out of wind with parallel faces, I do not believe there is a man here that would reject a tie if it had one face in wind and the other out of wind. He would not be justified in doing so, and it would not make any difference if he did.

(The amendment proposed by Mr. Hanna was adopted.)

The President:—The question is on the adoption of the paragraph as amended the second time.

(The question on the adoption of the paragraph as amended was decided in the affirmative.)

The President:—The Secretary will read the next clause.

The Secretary:—"Dimensions.—Except in pole ties, none shall be less than 8-in. face, and in no tie shall the thickness be less than 6 in. A variation in size will be permitted of ½ in. over in thickness, 2 in. over in width and 1 in. over in length.

Mr. Hendricks:—I move that the words "rounded sides" be inserted after the words "pole ties," making it read, "Except in pole ties with rounded sides," etc.

(The amendment was adopted.)

The President:—The question is on the adoption of the paragraph as amended. If there is no discussion, we will consider it adopted as amended, and proceed with the next paragraph.

The Secretary:—"In pole ties the face may be less than that given in the table of dimensions below, but the least area of cross-section shall be not less than the area corresponding to the tabular dimensions, and in no case shall the face be less than 6 in."

The President:—In connection with that paragraph we will consider the table of dimensions given in the Committee's report.

Mr. Curtis:—I think it might be well to call attention to two matters. It seemed desirable to the Committee, in trying to prepare a general specification covering all conditions, in all portions of the country, to arrange a specification so that each road could conveniently designate what tie they wanted, and for that reason we devised this scheme. For instance, if one road is using a 6-in. by 8-in. by 8-ft. tie, you would describe that as an "E-8 tie;" if another were using a 7 by 9 by 9-ft tie, you would describe that as a "D-9 tie." The Committee recommended this as a very simple and convenient method of describing the various dimensions in a few words. The other matter I want to call attention to is the fact that we have departed from the customary method in large contracts for ties, in that we have made no allowance for ties which are under size, provided they are under 6-in. thickness. I have discovered that many roads have two specifications, one on which they buy from farmers and one on which they buy from tie contractors. The specifications used with the farmers usually allow no under-run on the ties, but I have discovered, when it comes to buying 300,000 or 400,000 or 500,000 ties at a time, they are very apt to allow 10 per cent. under-run in dimensions. Personally, I advocated the adoption of that method, but there was a very strong feeling in the Committee that we did not want to have any percentages brought in; because, as it was expressed, it left it to the tie inspector to determine whether a certain tie should come in or not. In my own judgment, we were getting into exactly the very trouble we were trying to avoid. Suppose your specification calls for a 6 by 8 by 8-ft. tie, but it says 10 per cent. shall be received as first-class or second-class ties. The tie inspector inspecting a lot of 2,000 ties offered him would then accept 200 of those ties if they under-ran, and would know that he was com-

plying with the specifications. If, however, you had no percentage limit, you may say, in your contract, if you are buying 200,000 ties, you will receive 20,000 that are under-size. The inspector, when he examines 2,000 ties, has got to determine for himself how many under-size ties he will accept. He does not know how many have been accepted on that same contract; while if you give him a percentage he knows he can accept 10 per cent., or whatever percentage it may be, which under-run in size. I want the convention to understand that in adopting that clause they have made no provision for under-run in size and have no provision for a thickness of less than 6 in.

The President:—This proposed method of designating ties of different size and length is somewhat of a new departure, and we would like to hear the matter discussed before we act upon it.

Mr. Cushing:—I am very much disappointed in this specification, because I do not feel that it is giving us what we are striving for—more uniformity among the different railroad companies in the matter of specifications for cross-ties. I feel that the more uniformity there is, the better will be the market, the lower the price we will be able to purchase our ties for, and the greater the clearness in the whole cross-tie situation. Instead of bringing this down to a reasonable number of classes, which it seems to me we could easily agree upon, the number of classes has been made or continued practically as they probably are now, and I feel that we are not making the headway we ought to make in the matter of specifications. Some specifications are so near others that, by careful study on the part of the Committee, they might have boiled them down into a much fewer number of classes, and I do not feel that we are making any headway in the cross-tie business until we have done that.

The President:—It would seem that the question is, should we adopt a standard size tie?

Mr. Cushing:—That is really the gist of the whole matter; in other words, a study of the proper size of cross-tie from the work which it has to perform. The proper size of tie is now a matter of opinion among the different railroad men, arising from old custom. We find one railroad company with exactly the same class and weight of power and amount of traffic using a tie only 8 ft. long, and another road of equal importance using one 8½ ft. long, and again 9 ft. long. There must be some reason for that, or if there is not any reason, why should we not come to a common ground on which to stand? I am not prepared to say that I know how to design a cross-tie myself, but I feel that there is enough information to be obtained from the different roads that advocate different sizes to try and come to a standard requirement. Our standard tie is 8½ ft. long. It has been so years and years, ever since the railroad was built. We have ties presented to us in times of particular scarcity 8 ft. long. The question arises then, why should we not take an 8-ft. tie? The Big Four uses an 8-ft. tie; I do not know but what the New York Central does. They are roads of equal importance in traffic, and why is the difference? Well, we find we have a number of branch lines anyhow where we can use the tie, and

we make the purchase. From that standpoint I would like to have seen this matter of dimensions analyzed a little more particularly by the Committee, and I make the motion now that this tabulated statement be returned to the Committee for further investigation and study.

The President:—I think it is a question whether the Committee has not carried out its duty in regard to treating the tie as it is found. The designing of the ties is the duty of the Track Committee. Am I right or wrong about that?

Mr. Cushing:—My personal opinion would be that it belonged to this Committee.

Mr. Curtis:—It seems to me it would be rather a presumptuous thing for this Committee to try and tell the Pennsylvania Railroad what tie they ought to use. I am afraid they would advise us that it was presumption, at any rate. If you want to take up that question, you have the tabulated statement with about every size that anyone expects to use in this country. If the point is worthy of immediate consideration, and it certainly is, I think the proper thing is for this convention to take it up right now, and discuss the proper length and size of the ties. You can get more out of it in that way than the Commitee can, were it to take it up for years. It is a pretty big proposition, but it is certainly very desirable, if it is possible, to eliminate the great bulk of these dimensions and bring it down to, say, two sizes of ties; but I have not much hope that any such thing is possible.

Mr. Cushing:—I do not mean to intimate that the Committee is to make a suggestion that every company should take the size of ties recommended by the Association, but it seems to me it is entirely within the province of the Association to say what the Association thinks is a proper size of tie, leaving it, just as we have done in the case of all those other reports, to the individual companies to act according to their own ideas, after they have had this information presented to them; but I do feel that by presenting the information in that way, by degrees our differences will be more nearly harmonized than they are at present, and I feel that the entire situation will be put in better commercial shape, and that we can get ties even cheaper.

The President:—Will you please put your motion in shape, so that we can handle it, that is, to suggest the size of tie you wish to substitute for those recommended by the Committee?

Mr. Cushing:—I do not know that I am prepared to say. Of course I can tell you what we are using to-day. On the other hand, I am not prepared to say that we should stick to that. I am not going to say that I am so hidebound I can not change, if upon presentation of a proper argument and discussion of the subject there should be a change. I know that the matter has come before us in this way at times, and we are doing precisely like everybody else, buying different sized ties, according to our needs. Our standard ties are 7 by 8 by 8½ ft. That is probably about the average between these two extremes. We allow variation in the thickness and width, and slight variations in the length. As far as I know now, that is a good tie. I am quite willing to present

that tie as a recommended tie, but it seems to me it would be very much better to have it presented by the Committee, with a definite recommendation, after giving the matter full study from all the information they have. Our standard pole tie is 7 by 8, but when it comes to a split tie—by the way, when I speak of pole tie I am apt to get mixed in the Committee's definition, because a pole tie means to us one with rounded sides and parallel faces—it is 6 by 9, with about ¼-in. variation over or under in the thickness.

Mr. Wilson:—I do not think this is a question for this Committee. I do not think this Committee should undertake to specify the exact size of a tie which should be used, any more than that the Committee on Track should attempt to specify the weight or section of rail which should be used in the track. I believe there should be a symmetry between the rail and tie, and that we should have variation in the size of the tie, according to the weights it must carry and amount of traffic over it, and I believe this Committee is perfectly right in presenting a table from which the different classes of ties can be selected to fit the different uses to which the tie is to be put, and it seems to me that it is more in the province of the Committee on Track to give the size of ties as one of the component parts of the track. Therefore, it would not be right to use with a 60-lb. rail the same sized tie which we would use with an 80-lb. or 90-lb. rail, and the specifications of the Pennsylvania Railroad, made to fit the heavy traffic, should not necessarily be the guide used for construction sizes to fit the lighter traffic throughout the country; and there is also no more reason that the makers of ties can not fill the different dimensions shown in the table of sizes presented by the Tie Committee than that the rail manufacturers could not roll the various weights of steel rail.

The President:—Do I understand Mr. Cushing to make a motion?

Mr. Cushing:—I make a motion that this particular matter of dimensions be referred back to the Committee for further investigation and presentation of the subject with a view to reducing the number of classes.

Mr. Tye:—I think it would be advisable for the President to decide which committee this matter belongs to. I believe, with the President and these gentlemen, that it belongs to the Committee on Track, or perhaps it should be referred to a joint committee.

The President:—The chair will decide the question. It is the business of the Track Committee to design the kind of cross-ties to be used, in the same way that they design the thickness of the ballast and weight of rail.

Mr. Tye:—If that is so, why should this question be referred back to this Committee?

The President:—That is a matter for the convention to settle. Is there any further discussion on the motion of Mr. Cushing that this subject be referred back to the Committee for further investigation, with a view to decreasing the number of classes of cross-ties?

(The motion was put to vote, and decided in the negative.)

The President:—Mr. Cushing's motion is lost; the question is now on the adoption of the paragraph as presented by the Committee.

Mr. Hendricks:—I move that the words "with rounded sides" be inserted after the words "pole ties" in the second paragraph.

Mr. Tye:—In the paragraph before that the Committee says: "Except in pole ties, none shall be less than 8-in. face, and in no tie shall the thickness be less than 6 in.;" and in the table of dimensions they refer in two different places to a width of less than 8 in. That seems to conflict. That is, in Class F and Class G.

Mr. Hendricks:—The next paragraph reads: "In pole ties the face may be less than that given in the table of dimensions below, but the least area of cross-section shall not be less than the area corresponding to the tabular dimensions, and in no case shall the face be less than 6 in."

(The motion was adopted.)

Mr. Tye:—Then I presume F and G refer to pole ties.

Mr. Curtis:—I should say "yes" under those conditions.

Mr. Tye:—Your heading is "Thickness by Width." What do you mean by "width?"

Mr. Curtis:—Width is the face.

Mr. Tye:—Width of face or thickness of face?

Mr. Curtis:—The width of a pole tie with rounded edges is greater than its face. It would be an improvement, perhaps, to substitute the word "face" for "width." These two specifications, F and G, were put in to provide for the purchase of ties which go away below what the Committee think should be used. We do not advocate in the sawed tie anything like a 6 by 6 or 6 by 7, but they are actually sold, and it is put in for that purpose. There is an apparent conflict there which can be corrected in any way that seems best. "Thickness by face" would correct that in the simplest and quickest way.

The President:—The Committee accepts that amendment, and the heading of the second column of the table will be "Thickness by Face" instead of "Thickness by Width." Are you ready for the question on the paragraph as amended.

(The paragraph as amended was adopted.)

The Secretary:—"Ties must be piled on the right-of-way of the railroad at station yards or at points between stations designated in the contract, not less than 10 ft. from the nearest rail; each pile to be of either 25 or 50 ties, built with two ties on the ground and above in alternate courses of 7 and 2, except the tops, which shall be placed to form a watershed, as shown in cut. Each pile must be plainly marked with the owner's name. Three feet of space must be left between piles to allow easy inspection. Sawed ties must be piled separately from hewed ties.

"Ties shall be cut, as far as possible, in the winter period, that is, from October to March."

The President:—We will consider these two paragraphs separately, as some members may agree with the first and not with the second.

Mr. Hendricks:—This seems to take it for granted that all ties will be delivered on the right-of-way, while in many cases they will be shipped

in on cars. I move, instead of the paragraph reading as it does, that it be made to read, "Ties which are to be delivered along the right-of-way of a railroad must be piled," etc. I also move to add to that paragraph the following: "Contractors in shipping must load only one grade of ties on a car, unless otherwise specified."

Mr. Curtis:—The chairman of this Committee, Mr. Cushing, returned to me the discussion of Mr. Hendricks, which was sent in; and in regard to it communicated the points upon which he did not agree. He does agree with the suggestion that there should be a clause that rejected ties should be removed from the company's right-of-way within ten days after notice is given, and that will be accepted by the Committee. He does not, however, agree with the first suggestion made by Mr. Hendricks, nor does he agree with the paragraph regarding the shipping of one grade of ties in a car. That matter was discussed. I advocated it, but in the opinion of the Committee it was not practicable, and we left it out. They did not believe it was possible for you to compel or reasonably ask the contractor to ship the various grades of ties in different cars. As a matter of fact, they are often not graded until they are put on the ground.

Mr. Hendricks:—I have known of that being done in some cases, and there was no trouble, that I know of, from it.

The President:—We will first take up the question on the amendment proposed by Mr. Hendricks, to insert after the word "Ties, which are to be delivered along the right-of-way of the railroad." Hearing no objection to the amendment, it will be approved.

(The amendment was adopted.)

The President:—The next amendment is to add at the end of the paragraph the words: "Contractors in shipping must load only one grade of ties on a car, unless otherwise specified." Is there any discussion on the amendment?

(The question being put on the amendment, it was lost.)

The President:—The first amendment was carried, the second was lost. The Committee accepts the amendment that all rejected ties must be removed from the company's right-of-way within ten days after notice is given. The question is now on the paragraph as amended.

(The paragraph as amended was adopted.)

The President:—The last paragraph reads, "Ties shall be cut, as far as possible, in the winter period, that is, from October to March." I have often heard that disputed by very high authority as being at all advantageous. Perhaps some member may want to tell his experience on that question. Does anyone know whether it is best to cut timber between October and March? There seems to be no desire to discuss it.

(The paragraph as read was adopted.)

Mr. Berg:—I ask whether, this morning, under the head of "Definitions," the term for hewn ties was "hewn" or "hewed," and for sawed ties, "sawn" or "sawed?" The specification uses the terms sawed and hewed, while the definitions use the term sawn. I think we should adopt either hewn or hewed or sawn or sawed; either one or the other.

The President:—We have used them indiscriminately.

Mr. Berg:—As we have adopted definitions, had we better not have

our specifications correspond, and is it not distinctly on record what we did adopt?

Mr. Curtis:—Which do you consider the preferred term? Would you use sawed or sawn?

Mr. Berg:—I have no opinion on the matter at present.

The President:—I think the best way to dispose of that would be to refer it to the Committee and ask them to find out which is the right expression and to use it. Without objection, that will be done. I believe that disposes of the entire report, unless there is some discussion on the other features of it. Mr. Kinnear made a request that the Committee should define a tie, and the Committee will understand that it is asked to do so in its next report.

Mr. Churchill:— I wish to make one more request. Since the Committee has access to the specifications of the different roads, I request that they be asked to compile a record to determine how many miles of road are using each class of ties—I mean as to sizes—and that they be instructed to give a tabulated statement in their next report showing what the specifications of the different roads reveal as to the sizes of ties adopted by the different roads as standard.

The President:—The chair would suggest that this matter be referred to the Tie Committee, to collect the data and turn it over to the Track Committee for report to the Asssociation. Unless objection is made, the Committee is so instructed.

REPORT OF COMMITTEE NO. XIV.—ON YARDS AND TERMINALS.

To the Members of the American Railway Engineering and Maintenance of Way Association:

Your Committee, in preparing its fifth annual report, desires to state that, by reason of the widely scattered membership of the Committee, its work during the past year has been carried on principally by correspondence between the members.

In conformity with its previous report, your Committee has in this report taken up for its principal consideration two subjects: (1) Coal Piers; (2) Icing Stations. Ore piers are briefly discussed as being generally similar to coal piers. Your Committee has also fully considered the matter of piers at ocean terminals (which was discussed in its previous report), and presents additional information on this and other subjects.

HISTORICAL.

In the report for 1903, the difficulty of making any historical statement covering yards and terminals was referred to. It is believed proper that important changes in yard design and construction should be on record.

There are various claimants to the conception of the construction of the first summit yard in America. The Honeypot Yard, on the Sunbury Division of the Pennsylvania R. R., has claimants with dates varying from 1888 to 1891. It is also stated that the summit yard at Coxton, Pa., on the Lehigh Valley R. R., antedates the Honeypot Yard by several years. It may safely be assumed that the summit idea, in one form or another, was in use prior to any of these dates. The extensive clearing yard of the Chicago Union Transfer Co. is among the largest yards of the summit plan.

In Appendix C your Committee puts on record the history of the development of the car-transfer system of the New York, New Haven & Hartford Railroad at New York.

HANDLING CABOOSES IN YARDS.

In commenting upon the Committee report of 1902, Mr. Thomas Appleton wrote that both plans of "Types of Clusters" have many good features, but that both have one particular defect:

"In a cluster 2½ miles long the caboose tracks are shown at the outer ends of the layout, 1¼ miles from the center. In such a large cluster the headquarters of the officer in charge of the business, be he division superintendent, trainmaster, train dispatcher, yardmaster, or

engine dispatcher, would probably be at the center of the layout, near the engine house. The caboose is the office of the train conductor, where he makes out his reports, and is oftentimes the sleeping place of the train crew. Why not have the caboose tracks near the center of the cluster, and so have the train crews easily accessible to the officers? The road engine brings a train into one of the reception tracks, cuts off and backs around the train to the caboose, which has been stopped back of the switch, and takes the caboose and crew up to headquarters. It sets the caboose onto the caboose track, and the cabooses stand with the oldest one in front, ready to go out again."

In reply to this it may be said that the condition objected to is brought about by the desirability of avoiding switching of cabooses. In most of the yards of the country to-day the cabooses are switched all over the yard. It is more or less dangerous, takes time, and costs money. In offsetting this, the inconvenience mentioned by Mr. Appleton is introduced. In some cases the inconvenience is serious, though in most cases it is of advantage to locate the caboose tracks as shown on the Committee's plans, especially so when the ends of the yard are connected by telephone. In yards of the size shown there would probably be four yardmasters—two in the center and one at each end. This would put the caboose in touch with the man in charge.

COAL PIERS.

The term "coal piers" is generally taken to cover all piers or wharfs where coal is handled. The Committee here only treats of those piers in use by railways for handling coal from cars to vessels. These piers are variously known as coal piers, coal docks, coal wharfs, coal trestles, coal chutes, coal dumps, coal tipples, etc. They may be divided into two general classes:

(1) Piers where coal is elevated by machinery and then run by gravity into boats, or handled by machinery entirely.

(2) Piers where coal is handled from cars to boats by gravity, i. e., where the car is raised to such elevation as to allow the coal to run by gravity into boats.

A combination coal and freight pier of the Louisville & Nashville Railroad is noted among the rail and water terminals mentioned in Appendix A.

In the handling of coal it is important to prevent its breakage, as far as possible, but this breakage must occur more or less, and unless special care is taken this may result in great loss. The larger lumps are broken up into smaller ones and a large quantity of chips and dust is produced. As some of this fine stuff is lost and some of it is not used, there is a loss in the actual quantity of the coal. And since the smaller coal sells at a lower price, there is also a loss in quality. The above applies particularly to bituminous coal, since this is softer and more fragile than anthracite, and contains much more volatile matter. Anthracite coal is, of course, subject to the same deterioration, but in less degree. At points where coal is shipped in great quantities, deterioration

by breakage is an important matter, as it affects every ton of coal handled, and virtually increases the cost of handling the coal by the amount the coal loses in value and quantity. Means for reducing the breakage of coal in handling it, both by machinery and by gravity, at coal shipping piers, are noted further on in this report.

(1)—PIERS WHERE COAL IS HANDLED BY MACHINERY.

This type of pier, although especially adaptable under certain circumstances, is not in general use. The most common examples of these piers are where the cars are elevated and tilted bodily by machinery, and some of these piers and car-dumping machines are described later on in this report. Another type is where the coal is dumped from cars into a hopper and then elevated by means of an endless-chain elevator, or scraper, to such height that the coal will run into the boats by gravity. The operation is similar to that employed at many locomotive coaling stations. This type is adaptable to those locations where the upland, back of the pier, is limited, i. e., where there is not room enough to turn the cars so that they can be run on the pier. An example of this case is where the supply track runs at right angles to the pier and close to the shore end. Some plants of this type are noted further on in this report.

(2)—PIERS WHERE COAL IS HANDLED BY GRAVITY.

This type of pier is by far the most common and it is adaptable to almost any location. There are two general layouts for these piers:

(A) Piers having berths or water on one side only, such as a pier alongside of a canal.

(B) Piers having berths or water on both sides, such as piers running out into the water, square with the upland.

These two layouts are further divided into:

(1) Piers having locomotive inclines, or where the cars are placed on the upper level by a locomotive.

(2) Piers having inclines up which cars are hauled to the upper level by means of a cable and stationary engine.

(3) Piers where cars are run onto the pier at the upper level by gravity.

(A) PIERS HAVING BERTHS ON ONE SIDE.

(A1) PIERS WITH LOCOMOTIVE INCLINE.—The simplest example of this type of pier is where cars are placed by a locomotive and taken away again by the same means. (See Fig. 1.)

In the case of a level upper deck the cars have to be placed by the locomotive over the pockets, or chutes, into which the car is to be unloaded, or they must be moved along by the aid of pinch bars.

Another form of this same type of pier is to have the top deck on a grade, so as to be able to move the cars to any particular pocket by means of gravity. The top deck can be sloped in either direction. In cases where the top is sloping in the direction of the locomotive incline,

cars can be placed by the locomotive on the "tail tracks" and "spotted" by gravity over the proper pocket. In this case, when the locomotive incline is not too steep (preferably not over 2½ per cent.), the empty cars can be let down to the yard level by gravity.

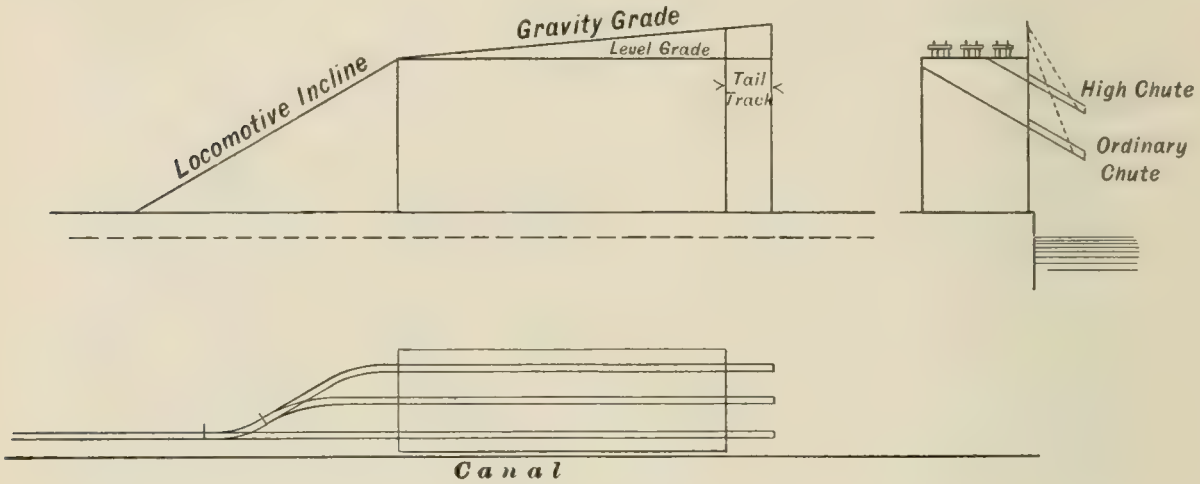


FIG. 1.

Another type of pier similar to the one above described is where the cars are placed on the upper deck by the locomotive and the empties are returned to the yard level by gravity. (See Fig. 2.)

This can be accomplished by placing the return track on the opposite end of the pockets to the locomotive incline, or by means of a switchback the cars are returned to the same end as the locomotive incline.

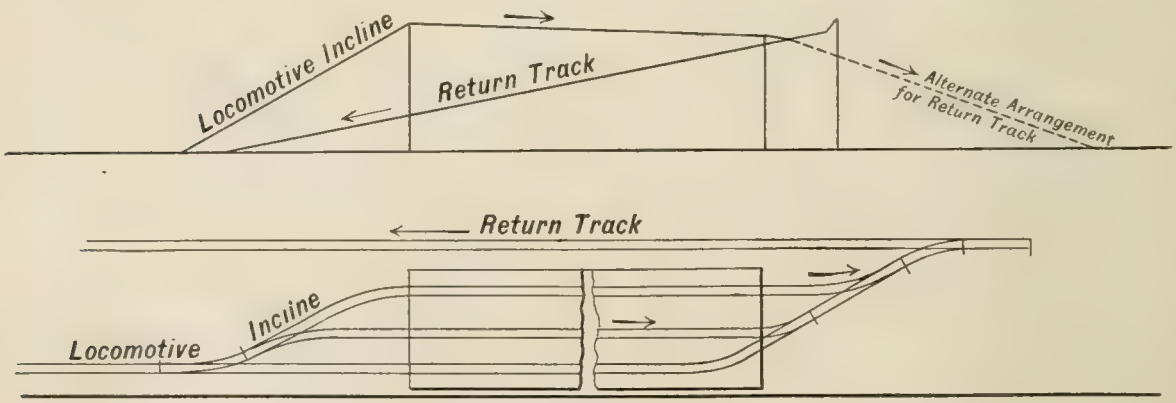


FIG. 2.

(A2) PIERS HAVING INCLINED PLANES AND BERTHS ON ONE SIDE ONLY.—This type of pier is similar to those described above, except that the inclined plane replaces the locomotive incline. (See Fig. 3.)

Another form of this same type of pier is to place the inclined plane at the side of the pockets, as shown in Fig. 4. This form has the advantage of being able to get suitable yard tracks ahead of the plane when the length of the layout is limited. A further advantage is that in case of accident to the machinery operating the inclined plane, the pier can be

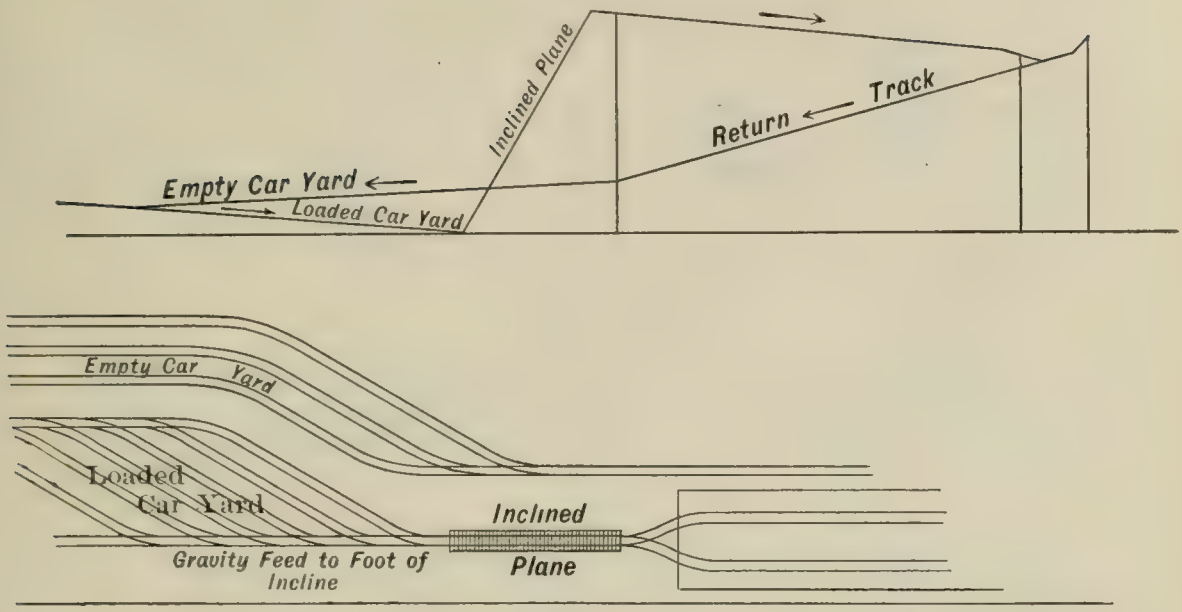


FIG. 3.

operated from the return track incline by a locomotive. In this case the pier takes on the characteristics of a pier described under the head of A1.

The supply tracks (loaded-car yard) should be so arranged that cars will feed to the foot of the incline plane by gravity.

(B) PIERS WITH BERTHS ON TWO SIDES.

(B1) PIERS WITH LOCOMOTIVE INCLINE.—The simplest type of this kind of pier is arranged similar to pier shown in Fig. 1, with berths arranged on each side. Where the top is level, it is objectionable on account of not having the assistance of gravity for moving the cars.

Another form of this type of piers is to have the empties returned from the sea end of the pier by means of gravity and a switchback (see

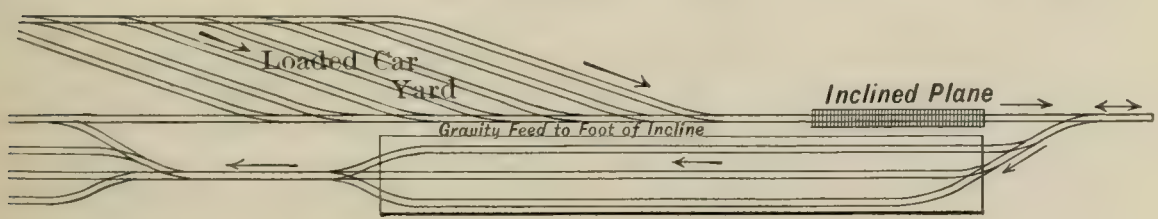


FIG. 4.

Fig. 5). Piers of this design usually have three or five tracks, the middle track (or "well track") being used as the return track.

Another arrangement for this type of pier is to have the locomotive incline placed on the pier, delivering the cars to the upper level at the sea end. The empties are returned by gravity to the yard at the shore end. (See Fig. 6.)

The advantage of this arrangement is that the sea end is made the high point of the pier and the location of the high chutes. This is de-

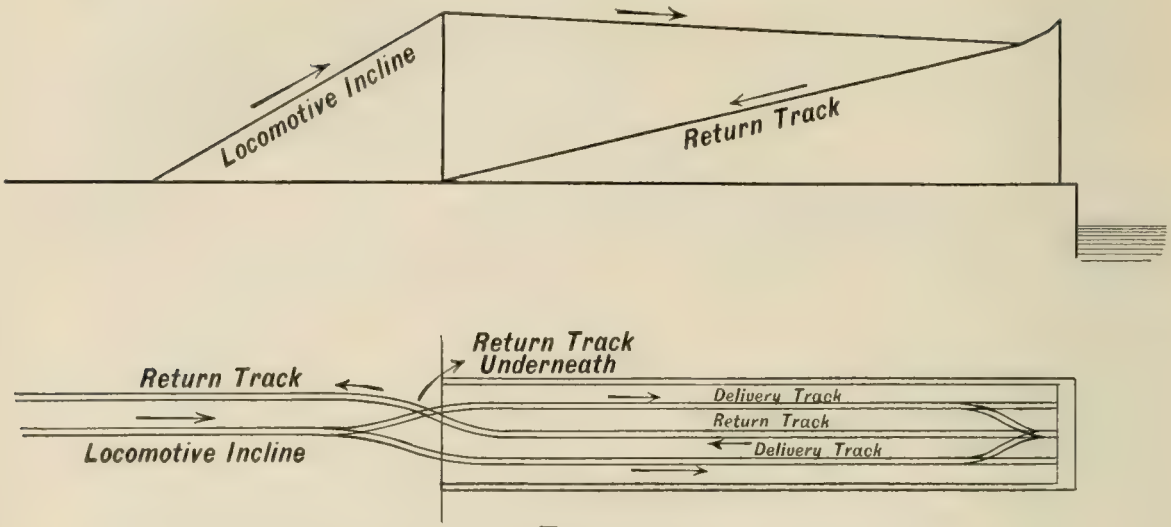


FIG. 5.

sirable, as it locates the berths for the large vessels at the sea end, which is the proper place for them. Another advantage of this arrangement, especially in the case of long piers, is that a very low grade incline can be used, thus increasing the tonnage a locomotive can place on the upper deck per trip.

This type of pier also economizes in space longitudinally; the shore end being the low point, space is saved in the length of the return incline.

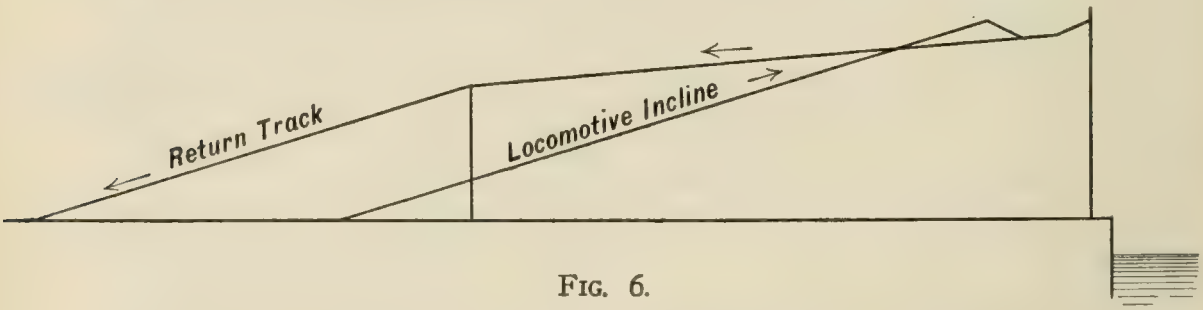


FIG. 6.

(B2) PIERS WITH INCLINED PLANES.—Inclined planes are usually resorted to where the room ahead of the pier is not sufficient for a locomotive incline. The usual practice is to have two inclines, one for each side of the pier. The pier is operated by gravity, and empties are returned by means of a switchback at the sea end. In all other respects, excepting the incline plane which replaces the locomotive incline, the pier is operated the same as described under head of B1. (See Fig. 7.)

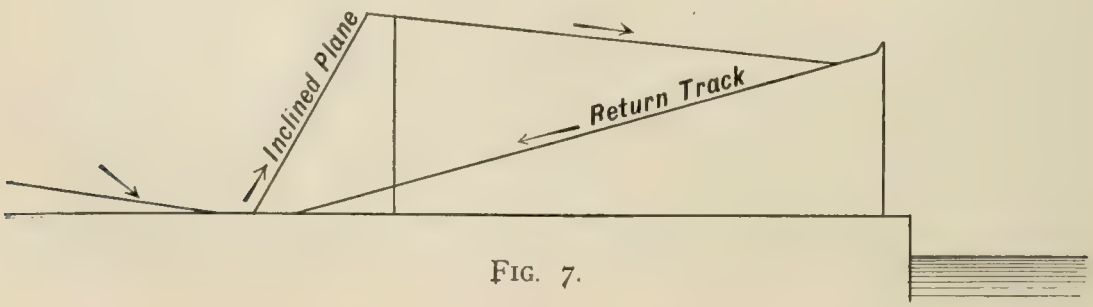


FIG. 7.

The supply tracks or loaded-car yard should be so arranged as to feed cars to the foot of the incline by gravity.

Another form of this type of pier is to place the inclined plane at the sea end, as shown in Fig. 8. This arrangement is particularly advantageous where the upland is limited and of sufficient height to feed cars to the foot of the plane by gravity. It has the further advantage of reducing the width of the pier. The location of the supply track, which is generally placed in the middle, is such that it does not require an open well. The tracks on the upper deck can be carried across the full

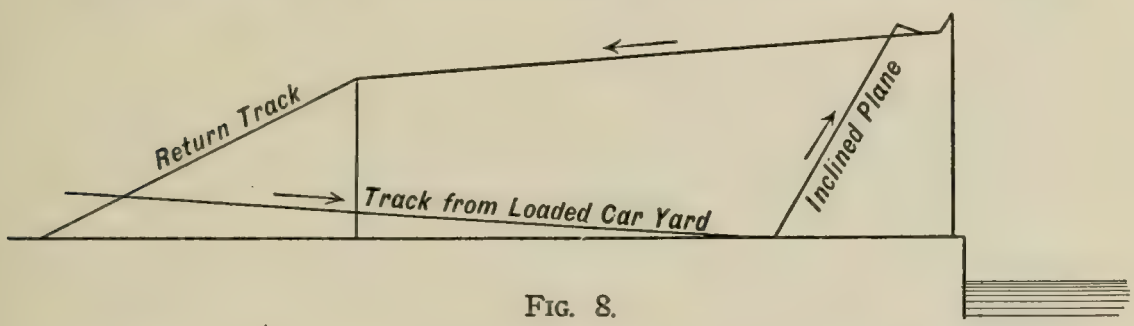


FIG. 8.

width of the pier, except for the hole where the incline plane elevates the cars. The saving in width of pier for this arrangement is about 12 feet for the entire length of pier.

This type also economizes in space longitudinally in cases where the general yard level is high. The shore end being the low point of the pier, the cars are returned about to the elevation of the yard.

(B3) PIERS OPERATED BY GRAVITY.—It sometimes happens that the piers are located where the upland back of the piers is high enough so that cars can be run on the upper deck by gravity. (See Fig. 9.) This arrangement is obviously the most economical in operation.

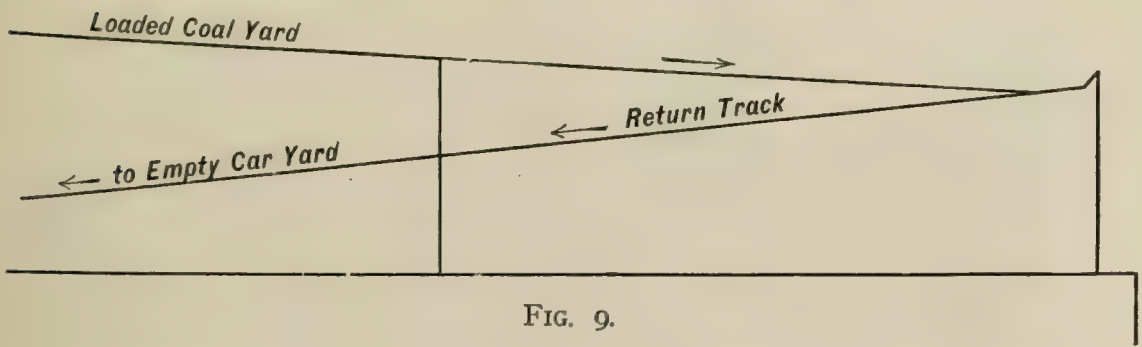


FIG. 9.

GENERAL FEATURES APPLICABLE TO ALL COAL PIERS.

SCALES.

Track scales should be provided for each pier where the business is such that it warrants it.

The location of the scales can be either at the head of the pier on the upper deck, or at the entrance of the loaded-car yard. At some piers

it is necessary to weigh the empty cars. In this case scales should be on the return track also.

VERTICAL CURVES.

The sketches accompanying this report do not show vertical curves at the change of grade. In all cases vertical curves should be provided for. In length the curves should extend over three or four bents, or for a distance of from 35 to 50 feet, and, where circumstances will warrant it, it is desirable to have longer vertical curves.

SWITCHBACKS.

Switchbacks should be made so as to work automatically. The usual method is to have a spring in head rod of the switch.

In some cases, where room is limited, a transfer table or a pivot table is used. Pivot tables are arranged to work automatically by means of a counterweight. The normal position is in line with the delivery track. Cars are run on the table, and the table moves, by weight of the car, to the return track; the car then moves off by gravity, and the counterweight then returns the table to its first position. (See Fig. 10.)

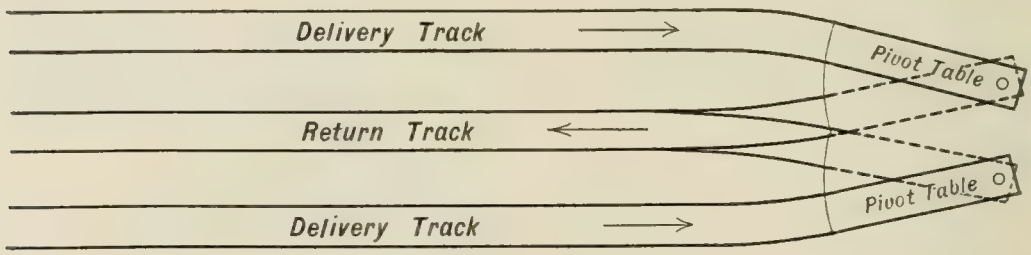


FIG. 10.

GRADES.

The grade for a locomotive incline may be made as steep as about 5 per cent., but seldom above this figure. In practice, however, most piers do not have over 3 per cent. grade on the approach. Where steep locomotive inclines are used, it is desirable to have a long track ahead of the pier for the locomotive to get up speed before reaching the incline.

The grades on the piers in practice are generally made from 0.8 per cent. to 1.5 per cent. It is difficult to determine just what grade to use. In summer time cars in good condition will run freely on a grade as low as 0.8 per cent. In winter time some difficulty is experienced even with higher grades. Usually where a grade is less than 1 per cent. a short sharp grade is introduced at the head end of the pier to give an impetus to the cars. It is also desirable to have a short sharp grade where the cars run on the switchback.

Grades of 1 to 1⅓ per cent. for the general grade on top of the pier are demonstrated in practice to be about right for piers in northern climates. Where a lower grade than 1 per cent. is used, a short grade of 1½ per cent. at the point where cars start to move by gravity is advantageous.

Grades for return track can be somewhat steeper than for the delivery tracks, but good practice is to keep the grades below 2 per cent., and preferably about 1⅓ per cent.

In practice where inclined planes are used the grades are from 12 per cent. to 25 per cent., usually 17 per cent. to 22 per cent.

ARRANGEMENT OF TRACK ON TOP OF PIER.

Where more than one track feeds a single chute it is desirable to arrange crossovers between the berths, as shown in Fig. 11. By means of these crossovers cars can be passed around any car that has been

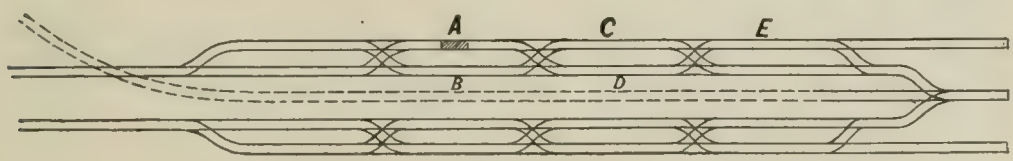


FIG. 11.

stopped over a chute for unloading. A car standing at (A) would block traffic on that track. Should a car on the track behind (A) be required at (C) or (E) it can be passed around the car standing at (A) by means of the crossovers on either side of (B).

INCLINED PLANES.

An inclined plane is operated by a cable and stationary engine, usually placed under the incline. There are two systems in use, one using a small car, or "barney," attached to the end of the cable, running on a narrow-gauge track between the standard track rails. This "barney" is dropped into a pit at the foot of the plane. Cars are then placed ahead of the "barney;" the cable is then wound up, the "barney" rises out of the pit and engages the rear end of the car. By means of the cable both are drawn up to the upper level. The "barney" is hauled back to the pit again by means of a small cable, ready for the next car. The other system is to have a continuous cable, the cars being attached to the cable by means of a short cable, having a hook on one end to engage an eye in the main cable, and a link on the opposite end to attach to the drawhead of the car by a pin. Where the continuous cable system is used the "bull" pulley should be placed far enough ahead of the top of the incline so as to prevent a downward pull on the drawhead. It is not customary to take up more than one large car at a time.

In most cases where piers have berths on each side and the return track in the middle, there is one incline for each side, with separate drums and engines. These drums are so arranged that the shaft can be connected by a clutch; thus, in case of a breakdown of one engine, the drums can be worked together. It is the practice, however, to use one incline at a time. The men employed on the inclines, both at the top and bottom, including the engineman, cross from one incline to the other as the cars are to be elevated.

SELECTION OF TYPE OF PIER AND ARRANGEMENT OF TRACKS LEADING TO PIER.

It may be stated that in most cases where inclined planes have been used, the room ahead of the pier is so limited that a locomotive incline for the shore end could not be considered. An inclined plane is, however, an economical arrangement where the tracks ahead of the pier can be arranged so as to feed the cars by gravity to the plane, thus dispensing with the services of a locomotive. Where this arrangement is not possible, and a locomotive is required to feed the cars to the plane, it is more economical to let the locomotive place the cars on the upper deck, if room is available. This arrangement is also more elastic than when the incline is used, as it allows more locomotives to be added when traffic is heavy. One engine can be employed in pushing cars up the incline while others are sorting cars in the yard.

In all cases tracks should be arranged to make the least number of shifting operations in the yard. Usually a large number of short tracks are required to sort cars with the different sizes and kinds of coal. Hence, when this is the case, the loaded-car yard should consist of a number of short tracks or a "gridiron" arrangement with ladder at each end. For the empty-car yard, usually a few long tracks will suffice, as no sorting is necessary. In all cases where steep locomotive inclines are used, a long track should be provided so that the train can get up speed to overcome the grade on the incline.

Where the loaded-car yard is at such a height that cars can be run on the upper deck of the pier by gravity, the loaded-car yard can lead directly onto the pier.

Obviously piers that are so situated that the yard together with the pier can be operated by gravity are by far the most economical.

EXAMPLES OF COAL PIERS.

As a matter of interest, and as showing examples of actual practice, your Committee submits illustrations and descriptions of certain piers operated on the several systems already mentioned, together with a tabulated list of a number of other coal piers. (Table No. 1.)

COAL PIER WITH CAR-DUMPING MACHINE.

Coal pier of the Delaware, Lackawanna & Western Railroad at Hoboken, N. J.—This new pier, built during 1903, and expected to be in operation by January, 1904, is one of the best examples of its special type. It is equipped with the first McMyler machine for handling anthracite coal, and has also a very complete system of adjustable screens for screening the coal after it has been discharged from the cars and before it is delivered to the vessel. The screenings pass to a set of storage pockets and by means of a conveying system they are delivered at the power plant furnishing steam for the machinery. There will be two car-dumping machines and a very complete arrangement of hauling machinery for

handling the cars. At the request of your Committee Mr. Lincoln Bush, Chief Engineer of the Delaware, Lackawanna & Western Railroad, has furnished information respecting this pier. Its total length from sea-wall to sea end is 1,283 feet, with a width of 72 feet at the sea-wall or inshore end and 60 feet at the sea end. The height above water is 4 feet 6 inches, the top being level. The depth of water at the pier is 25 feet. The grade of the approach from the high ground is 1 per cent. down to the pier. The delivery track runs to the center of the pier and all cars are moved by gravity, with the exception of the loaded cars from the shore end to the car dumpers. These are handled by an endless wire rope haulage system. The approach consists of the loaded-car yard of fourteen tracks. The delivery track on the pier is level, while the two return tracks have a grade of 2 per cent. on and beyond the pier. There are no storage pockets, the coal being delivered directly to the vessels from the cars by means of the two dumping machines, one on each side of the pier. The maximum tonnage that can be delivered to vessels is estimated at 2,000 tons per hour.

The present machinery equipment includes the two car-dumping machines (operated by steam), one on either side of the pier. The plant is equipped with all the necessary machinery for handling and dumping the cars, screening the coal, delivering the coal to vessels, and delivering the screenings to pockets. There are four steam dock winches for moving vessels, and three steam hauling engines for transferring the loaded cars from the shore end of the pier to the car-dumping machine and the fuel pockets. Two steam haulage engines are provided for elevating the empty cars at the shore end of the pier. There are four boilers of 250 H. P. on the bulkhead at the shore end of the pier, and also one fire pump.

The pier is cigar shaped, and at the inshore end (immediately adjoining the pier) is the storage yard, or loaded-car yard, of fourteen tracks, with a capacity of 428 loaded cars. On each side of this is an empty-car yard of five tracks, with a total capacity for 292 empty cars. The system is so arranged as to take the loaded cars out on the pier, discharge them and return them to the empty-car yard without the use of a locomotive, except to relieve the empty-car yard once during the day. The loaded cars are set in the loaded-car yard during the night.

The cars to be discharged into vessels are assorted according to the kind of coal they contain as they are put in the storage yard. Then as many cars as are required of the different sizes of coal are dropped down the tracks of the loaded-car yard by gravity, to a point about 100 feet out on the pier, where they are weighed. From this point they are hauled down two loaded-car tracks in the center of the pier by an endless wire rope haulage system, to a point in the center of the pier, where two car-dumping machines are located, one on each side of the pier. The loaded cars pass between these two machines and are delivered to a point beyond them on the outside of the pier, by gravity to a haulage car or "barney." Here the car begins the return journey. It is hauled by the haulage car, which is operated by a haulage engine, up a grade of 4.23 per cent. to the car dumping cradle. The car is locked in this cradle, and the cradle is raised with the car on it to the proper height. The car

TABLE I.—RAILWAY COAL PIERS.

RAILWAY.	Location.	Date When Built.	Size. Feet.	Approach. Method of Elevating Cars.	Approach. Grade Per Cent.	Approach. No. Tr'ks	Gr. of Deliv'ry Tracks. On Pier Per Cent	Gr. of Return Tracks. On Pier Per Cent.	Gr. of Return Tracks. Beyond Pier Per Cent.	Height. Shore End Feet.	Height. Sea End Feet.	No. Tracks on Upper Deck.	No. Return Tracks.
N. Y., O. & W.	Cornwall, N. Y.	1892	ABOUT 50x700	Inclined Plane Sea end	.....	1	.....	.....	.....	.....	.....	4	2
P. R. R. No. 5	Greenwich Pt., Philadelphia	1888	56x650	Loco. Incline Shore end	ABOUT 2.	1	0.3	0.3	2.0	28.	30.	4	2
P. R. R. No. 6	Greenwich Pt., Philadelphia	1902	735x50 to 60	Cable Incline Sea end	17.5	3	1.	2.8	1.5	65.	57.5	2	1
N. Y., S. & W.	Cliffside, N. J	1893	65x957	Inclined Plane	20.	2	0.87 & 1.22	2.08	.....	31.7	25.	4	1
P. & R.	Port Richmond, Philadelphia	1893	ABOUT 54x700	Loco. Incline	2.95	2	1.39	1.39	.....	.....	ABOUT 23.	.....	.....
P. & R.	"	1898	55x761	Loco. Incline	1.25	.....	1.25	.....	.....	43.4	.....	4	.....
P. & R.	Port Reading, N. J.	1891	56 wide.	Loco. Incline	3.	2	1.53	3.	.....	36.	19.	4	2
N. & W.	Lambert's Point, Va.	1890	ABOUT 50x805	Loco. Incline	2.5	1	0.732	2.5	1.0	42.	35.	2	1
N. & W.	" " "	1902	56x850	Inclined Plane	25.	2	0.667	2.833	2.833	72.8	74.6	2	1
D. L. & W.	Pier No. 10. Hoboken, N. J.	1884	64x995	Inclined Plane	16.	2	1.0	0.8	.....	35.	25.	4	1
D. L. & W.	Hoboken	1903	1283x60to72	Gravity	1.	.....	level.	1.	1.	4.5	4.5	.....	2
C. R. R. of N.J.	Jersey City, N. J.	1887	38 wide.	Loco. Incline	2.64	2	1.46	3.	.....	29.	20.6	2	1
D. & H.	Weehawken, N. J.	1887	.....	Inclined Plane	17.5	1	1.38 1.04	1.74	.....	35.	.....	4	1
B. & O.	St. George, S. I.	1892	ABOUT 300 long.	Loco. Incline	.....	1	level.	.....	.....	.....	.....	.....	.....
B. & O.	Philadelphia, Pa.	1893	40x700	Loco. Incline	2.	2	level.	.....	.....	18.5	18.5	2	1
B. & O.	Curtis Bay, Baltimore	1900	800x60	Loco. Incline	1.5	2	1.5	2.5	—1.	45.	45.	2	2
Erie	Weehawken, N. J.	1891	.....	Inclined Plane	20.	2	0.87 1.22	1.4	.....	36.	26.5	4	1
L. V. R. R. Pier A	Perth Amboy, N. J.	1886	70x800	Gravity	0.6	4	0.6	1.0	.....	29.5	25.	4	1
C. & O.	Newport News, Va.	1882	44 wide. 275 long.	Loco. Incline	2.03	2	0.9 0.6	0.6	.....	.....	22.	2	1

is revolved on an axis parallel to its sides until its load has been transferred to an apron 45 feet wide, the cradle and apron being capable of handling any sized car used in the coal trade. It handles a load comprising car and contents, of 160,000 pounds. The coal passes over screens located in the bottom of the apron and into a telescopic chute at the end of the pan, through which it flows into the hold of a vessel. The car and cradle are righted and lowered again. Another loaded car entering the cradle ejects the empty car and starts it down a 1 per cent. grade to the inshore end of the pier. Here the car is hauled up a 16 per cent. grade by a haulage car to a height of about 20 feet, which is sufficient to allow the car to run by gravity the entire length of the empty-car yard.

COAL PIERS WITH COAL CONVEYORS.

Coal pier of the Northern Pacific Railway at Tacoma, Wash.—At this plant, coal is discharged from hopper-bottom cars on a track on an elevated trestle over the storage bunkers. From there it is discharged into two link-belt conveyors, which deliver it to a third conveyor at right angles to them and to the trestle. This runs through a conduit under the tracks and into a headhouse on the pier, where the coal is delivered to a discharging apron or chute which can be raised or lowered or adjusted in length to suit the hatchways of different vessels. The machinery is operated by electric motors. Storage capacity of bunkers, 17,000 tons; discharging capacity, 600 tons per hour. This plant was built by the Link-Belt Machinery Company, of Chicago, which has also installed several similar plants.

Coal pier of the Southern Railway at Mobile, Ala.—At this port the railway has a conveyor plant for loading coal into vessels. The coal is delivered from hopper-bottom cars into pockets, from which it is discharged through chutes into a continuous conveyor. A movable filler prevents the spilling of coal at the loading point. The conveyor elevates the coal and delivers it to movable weighing hoppers, which are placed on top of the pocket, and from which it is delivered to the vessels. If the coal is for storage it may be retained in the pockets until required. The conveyor consists of a series of sheet steel buckets, having a capacity of 5.4 cubic feet when level full. The conveyor is operated at a speed of about 16 buckets per minute and handles about 150 tons of coal per hour under normal conditions. The plant was built by the C. W. Hunt Company, of New York, and completed in March, 1901.

A somewhat similar plant for the Plant System of railways has been built by the C. W. Hunt Co. for delivering phosphate rock to vessels. The rock is dumped from hopper-bottom cars standing on a track on the ground into a pocket below the track, and falls into a conveyor which runs diagonally to a tower at the end of the pier. The conveyor rises through this tower and travels horizontally along the top of the pier, delivering the rock to three movable chutes, which are shifted to suit the position of the vessels' hatchways. Each chute is so swiveled that it may be housed when against the pier or extended to any position within its radius. There are two swivels on the chute, one at its connection with

the trestle and the other about midway in its length, so that it may be moved readily without interference with the rigging of the vessel lying at the pier. This conveyor has rather heavier buckets than the other, in order to stand the abrasion from the rock. The plant has handled 200 tons of rock per hour.

Coal Pier of M. A. Hanna & Co. at Ashtabula, O.—At this pier is a conveyor plant, handling coal direct from hopper-bottom cars to vessels. The car runs on an elevated track on the pier and dumps its contents into a pocket or bin, which feeds to an inclined conveyor of the scraper type inclined at a steep angle. A steel gate or slide is placed at the opening of the pocket, 3 feet square. The head of the conveyor is in a tower on the edge of the pier. Pivoted in the tower is a frame carrying an extension of the conveyor, the outer end of this being supported by cables from the top of the tower, so that the conveyor can be adjusted to the height of the vessel and also raised to clear the rigging, etc., when a vessel is moving alongside the pier. From the end of the pivoted section of the conveyor is suspended a vertical chute or spout, which is made telescopic and can be swung sideways. When beginning to load, the bottom of the chute is lowered to the bottom of the vessel's hold and the chute allowed to fill with coal; it is then gradually raised as the vessel is filled, thus keeping it full of coal, so as to prevent breakage of coal by dropping it from a height. The chute is closed and raised clear of the vessel when the latter is to be moved. It has a trimming device for trimming the coal between the hatches, thus doing away with manual labor. The plant is operated by a 25 H. P. steam engine, and requires only three men: one engineman, one fireman, and a man on a platform at the head of the pivoted conveyor to operate the delivery chute. The plant was designed to load 600 tons per hour, but has actually loaded 900 tons per hour. A similar plant for the Pittsburg Coal Company, at Fairport, O., has a 50 H. P. engine to drive the conveyor, and a small hoisting engine to operate the pivoted section. It is operated by two men. Both these plants and one for the Ironville Dock & Coal Company, at Toledo, O., were built by the C. O. Bartlett & Snow Company, of Cleveland, O.

COAL PIERS WITH GRAVITY CHUTES.

Coal pier of the Baltimore & Ohio R. R. at Curtis Bay, Baltimore, Md.—This new pier was built and opened for business on September 24, 1900. It is 800 feet long from shore line to deep water terminus, is 60 feet wide and 45 feet high, and its operations are almost automatic.

The loaded car approach is 1,000 feet in length and rises gradually on a grade of 1½ per cent. to the top of the pier. At the summit the cars run over a 100-ton Fairbanks track scale and are automatically weighed. As cars can be unloaded on both sides simultaneously, each track has its set of scales. After the weighing the cars run to the unloading pockets. These are made of steel, each ending in a long steel spout, which is dropped to the vessel's hatchway. There are 25 of these pockets and spouts on each side of the pier, two being assigned for anthracite coal.

FIGS. 12 and 13

Am. Ry. Eng. & M. W. Assn.

Committee on Yards and Terminals.

Convention of 1904.

NEW COAL PIER AND YARDS,

CURTIS BAY BRANCH, B. & O. R. R.

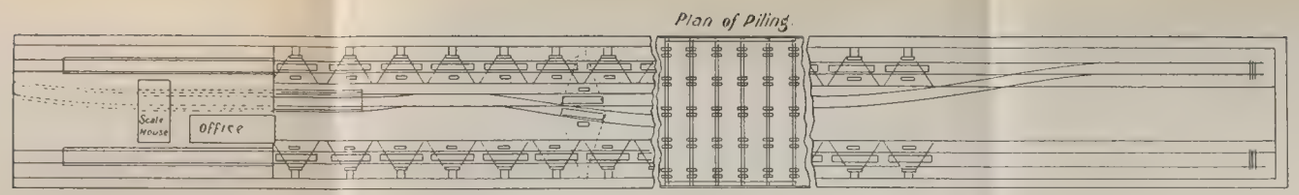
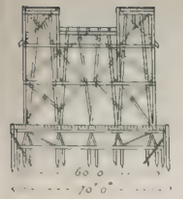
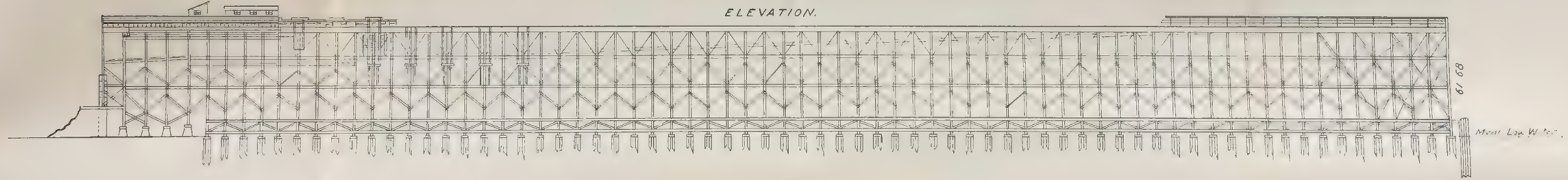


FIG 12.

B & O. R.R.
NEW COAL PIER
CURTIS BAY.
M D.





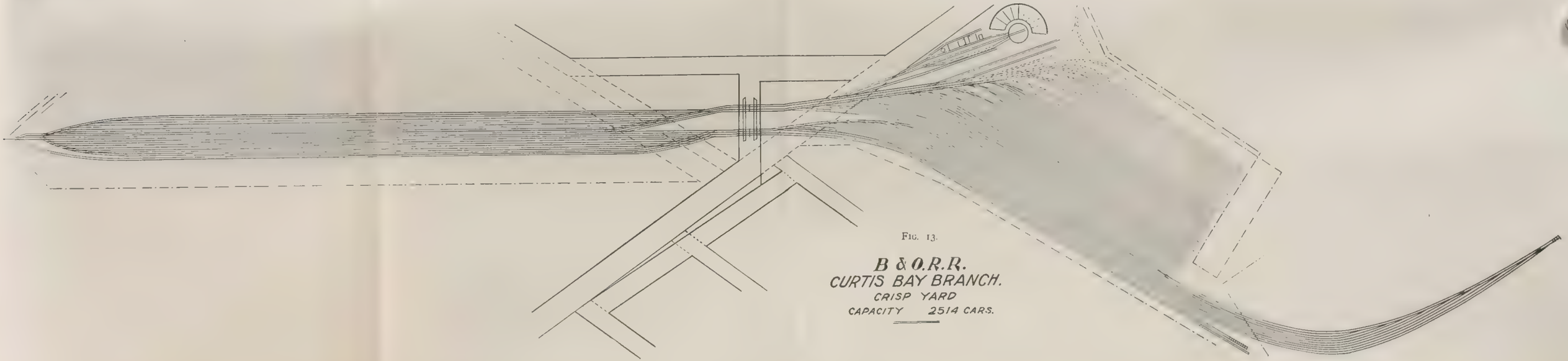


FIG. 13.

B & O.R.R.
CURTIS BAY BRANCH.
CRISP YARD
CAPACITY 2514 CARS.

When the drop bottoms of the cars are opened and the coal has been dropped, the cars run by their own momentum to the "switchback" at the end of the pier. Here they reach the return track and run down an incline of 1,800 feet to the yard, being weighed on a third pair of automatic scales while moving.

With the use of 50-ton steel cars and a requisite amount of vessel tonnage, the maximum capacity of the pier will be approximately 1,000 tons per hour. The superstructure of the pier provides possible arrangement for storage pockets, of which 100 can be erected, holding from 180 to 350 tons each.

The coal pier is built in a most substantial manner of Georgia pine, and some 8,000,000 feet of lumber was used in its construction. A channel 300 feet wide and 30 feet deep has been constructed from the entrance of the bay to the shore line of the pier, so that any vessel which can navigate Chesapeake Bay can load at this pier. (Drawings and views are given in Figs. 12 to 17.)

Coal Pier of the Philadelphia & Reading Ry. at Port Richmond (Philadelphia, Pa.).—Pier No. 11 was built in 1898, and has proved very satisfactory. It is 761 feet 2 inches long, measured on the wharf log, and the length of trestle is 878 feet 6 inches; the width is 61 feet on the wharf log and 55 feet on the deck. The depth of water, at mean low water, is from 22 feet at the shore end to 26 feet at the river end of the pier. The height to base of rail is 43 feet 4 inches at mean low water and 49 feet 4 inches at mean high water. There are now 31 chutes on the pier, five having been added since the pier was erected. The grade on the pier is 1¼ per cent., and on the approach it is about the same. The pier has a single deck on which four tracks are laid, all of which are used as return tracks, with switches so arranged that light cars are shifted to the two middle tracks near the shore end of the trestle. The arrangement of switches also permits cars to be run around other cars standing over chutes at either berth.

There is a smaller pier at the same place, with the return track in the center, and depressed. Each type has its advantages, depending upon the height of the yard above water, the available distance from approaches, character and volume of traffic, etc.

Coal Pier of the Pennsylvania Railroad at Greenwich Point, Philadelphia, Pa.—The new pier, No. 6, which was built in 1902, is 735 ft. 2 ins. long, with a width of 50 ft. at the outer end and 60 ft. at the shore end. Its height from water line to rail is 65 ft. at the shore end and 57 ft. 6 ins. at the outer end. The depth of water at the pier is 30 ft. The approach has three tracks on a down grade of 1 per cent. to the foot of a cable incline of 17.5 per cent. The pier has two tracks. The delivery track runs to the outer end of the pier on a grade of 1 per cent.; the return track has a grade of 2.8 per cent. on the pier and 1.5 per cent. beyond the pier. The pier has 40 pockets and chutes, 20 on each side, and the maximum capacity of delivery to vessels is 1,500 tons per hour. Loaded cars are run by gravity from the yard to the foot of the incline, up which they are hauled by a stationary engine and cable. They are then

Fig. 15.—Coal Pier from the Shore, Showing the Chutes; Baltimore & Ohio R. R.

FIG. 16.—TOP OF COAL PIER, SHOWING THE 100 FOOT SCALE. BALTIMORE & OHIO R. R.

FAIRBANKS
STANDARD
R.R. TRACK SCALE

run or "spotted" by gravity to position for unloading. The empty cars run by gravity to the outer end of the pier, and then run by gravity down the return track to the surface of the ground, at about 1,000 ft. from the shore end of the pier. This is shown in Fig. 18.

Coal pier of the Norfolk & Western Ry. at Lambert's Point, Va. —This pier is of class B-2, having an incline operated by cable and "barney."

The boiler house contains three Geary water tube boilers, rated at 545 H. P. These were furnished by the Oil City Boiler Works, Oil City, Pa. The hoisting engines are two in number, one being for emergency. They were built by the Lidgerwood Manufacturing Company, of New York, and each is capable of a straight pull on a single line of 50,000 pounds at 400 lineal feet per minute.

The hoisting cable passes over a 72-inch steel sheave at the top of pier. This cable is 1½ in. in diameter, of plow steel; length, 700 feet. The "barney" car is hauled down by 800 feet of ½-in. steel tail rope. This car was built by the Lidgerwood Manufacturing Company on plans approved by the railway company's engineers.

On the pier are three 100-ton automatic scales, with the Amet weighing device. The scales were furnished by the Fairbanks Co., of Baltimore.

The device for hoisting the chutes is the pattern known as the Denton counterbalance hoist, manufactured by Pettibone, Mulliken & Co., of Chicago.

The American Bridge Company, of New York, built this pier, while the piling and bulkhead, and approaches thereto, were built by John P. Pettyjohn & Co., of Lynchburg, Va.

The following particulars are taken from an article in the "Railroad Gazette" by Mr. George L. Fowler:

The company's terminal at Norfolk has extensive coal piers, which are located at Lambert's Point, for delivery of Pocahontas coal to vessels lying alongside. They are three in number. The first that was built is a wooden trestle, the second is of steel. In both of these the cars are pushed to the top of the incline by a locomotive, and are then dropped down by gravity to the chutes, where they are discharged into hoppers; whence the coal is drawn into the vessels. The cars then drop down over a switchback to the surface of the yard.

The third and last pier that has been built is of steel and is shown in the illustrations (Figs. 19 to 24). The reproduction of the photograph shows the general appearance with a car part way up the incline. The cars are set down into a four-track gravity yard by the switching engine, whence they are dropped down one at a time to the foot of the incline. Here there is a barney car moved by a cable, the "barney" running down into a pit between the main rails to permit the passage of a car. As soon as the car reaches the foot of the incline, the push car is brought up against the rear drawbar and pushes the car to the top. Here it runs upon a gravity incline, passes on the scales, where it is automatically weighed by the Streeter-Amet automatic weight recorder. It then runs down the chutes, where it is emptied, and thence on the switchback at the outer end of the pier. It comes back by gravity over a central track and out upon the yard.

A great saving in switching service is effected by this structure. All

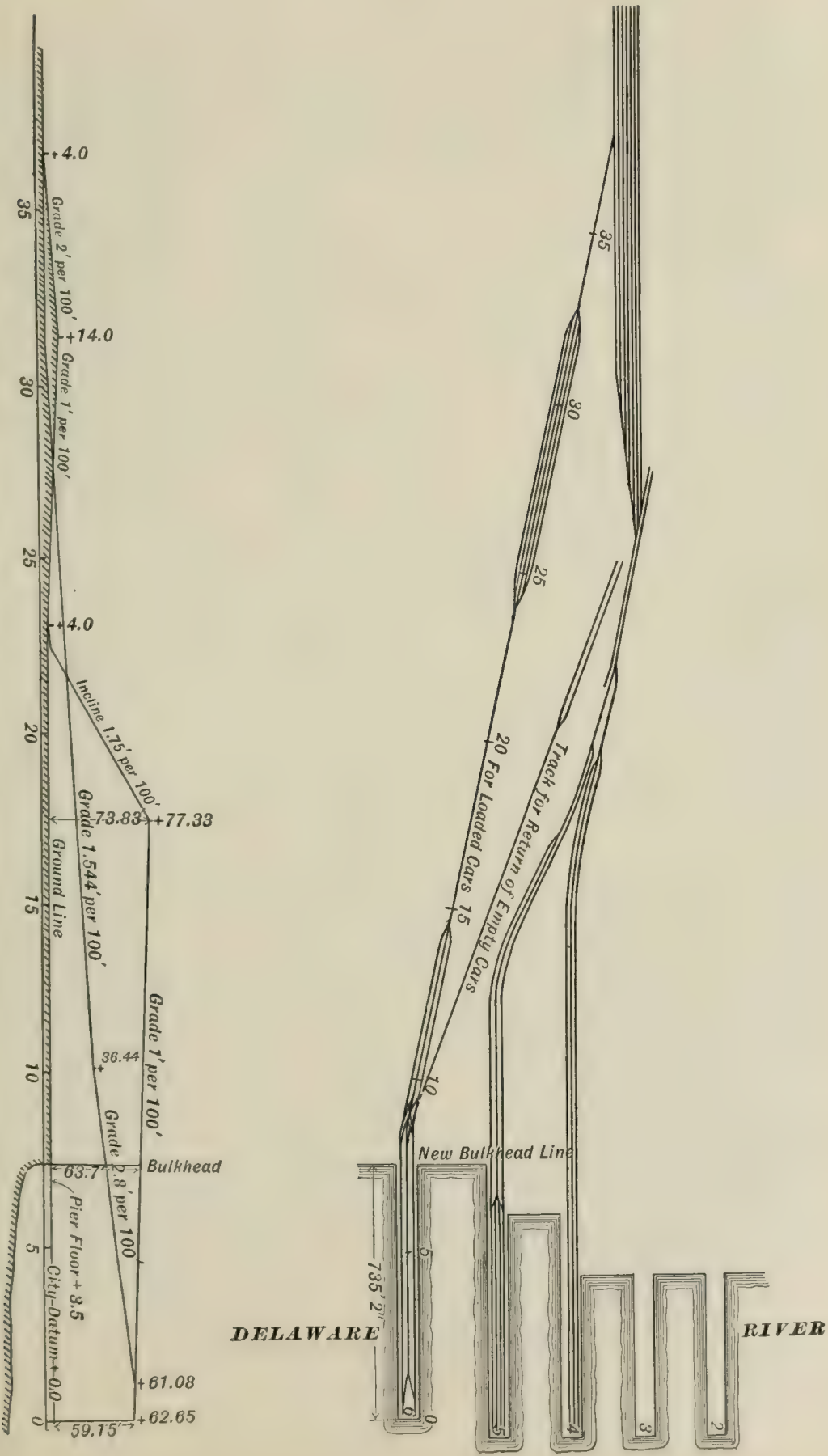


FIG. 18.—COAL PIER AT GREENWICH POINT, PHILADELPHIA, PA.; PENNSYLVANIA R. R.

that is required of the yard engines is to push the cars in upon the gravity yard delivering to the foot of the incline, and to haul away the empties when they have reached the foot of the switchback track. The speed with which the cars can be handled is about one every three minutes, or 20 an hour. This is, however, at times somewhat faster than the coal can be taken care of, stowed and trimmed in the vessels, so that the actual number of cars handled is then limited by the size and character of the vessels receiving the coal; but very prompt service is always furnished. These cars are all of 50 tons capacity, the smaller cars being unloaded on the other two wharves.

The average tonnage delivered at this terminal was 196,888 per month, for 1902, which is only rendered possible by the excellent facilities for handling and weighing cars that have been provided.

The general plan of the terminal with an outline side elevation of pier No. 3 is shown in the drawings. The switch connections are such that piers Nos. 1 and 2 are served by engines pushing the loaded cars to the top of the incline, whence they drop by gravity to the outer end of the pier and thence over the switchback to the two tracks reserved for empties, as already stated. The method of handling for pier No. 3 has already been described. The yard tracks drop down to the barney pit on a grade of 1.33 per cent., from which point the incline rises on a grade of 25 per cent. to the top of the pier at a height of 72 feet 2 inches above mean high water. From this point the grade along the top of the pier over the pockets is 0.667 per cent., while that of the return track after passing the switchback is 2.833 per cent.

The cross section shows the arrangement of the chutes for delivering coal to the vessels, and the method of counterbalancing. It also shows the relative locations of the two delivering tracks and that for the return of the empty cars. On the longitudinal section will be seen the means that have been taken to avoid an excessively high drop for the coal due to the height of the pier. After falling into the pockets the coal is carried to one side before reaching the chute, so that it enters the latter at a lower point than would otherwise be possible. There are 24 regular pockets upon each side of the pier, whose chutes have a maximum and minimum height of delivery of 31 feet and 27 feet above mean high water, respectively.

At the center of the pier and at each end there is a bunker pocket and chute, the latter delivering at a height of from 43 feet to 47 feet above high water. The height of the pier makes it specially suitable for promptly supplying coal to the bunkers of ocean steamers.

The main pockets are spaced 25 feet from center to center, and the chutes are arranged to swing 12 feet 6 inches on either side of the center, so that coal can be delivered at any point along the whole length of the pier, and any arrangement of hatches on the vessel be reached, without involving the necessity of warping the latter into a position that may be inconvenient.

The working of the pier is carried on with remarkable smoothness. A few men in the yard drop the loaded cars down to the barney pit, one at a time; the engineman is signaled to start and the car is pushed up the incline, where another man boards it and drops it down over the chutes. After it is dumped, a third runs it over the switchback, where it is automatically turned into the center track by a spring switch. And finally the empty cars are run down into the yard in strings of five or six, whence they are made up into trains to be returned to the mines.

In spite of the fact that the floor of the car stands 75 feet above mean water level, and the bottom of the hold of some of the vessels to be loaded is 10 feet below this level, the arrangements are such that the breakage of the coal is no greater than where the total fall is much less. This

FIG. 19.—COAL PIER AT LAMBERTS POINT (NORFOLK, VA.); NORFOLK & WESTERN R. R.

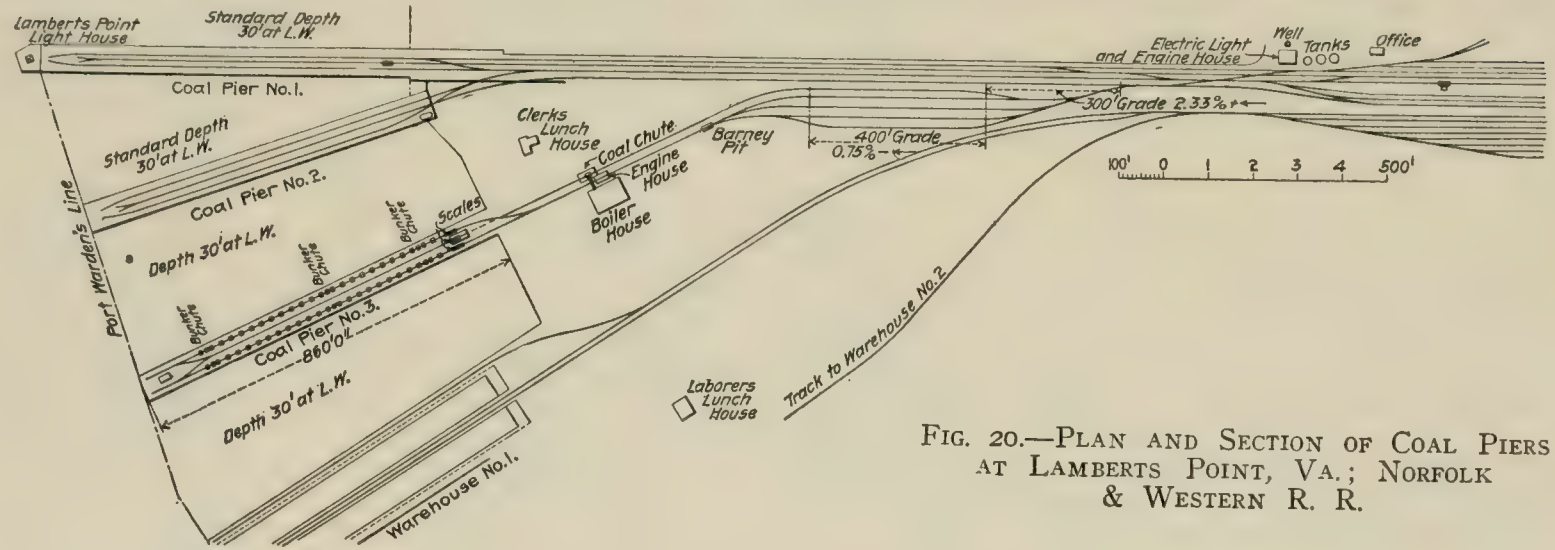
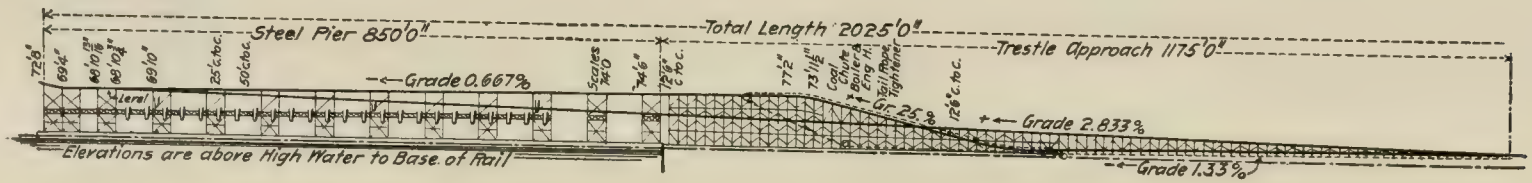
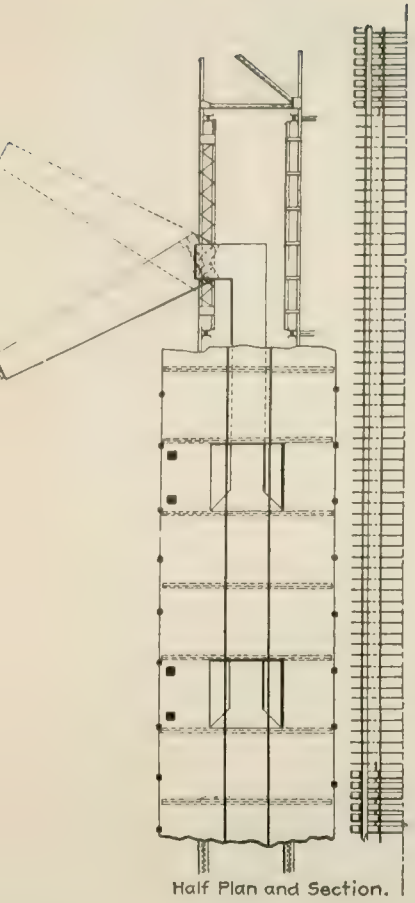
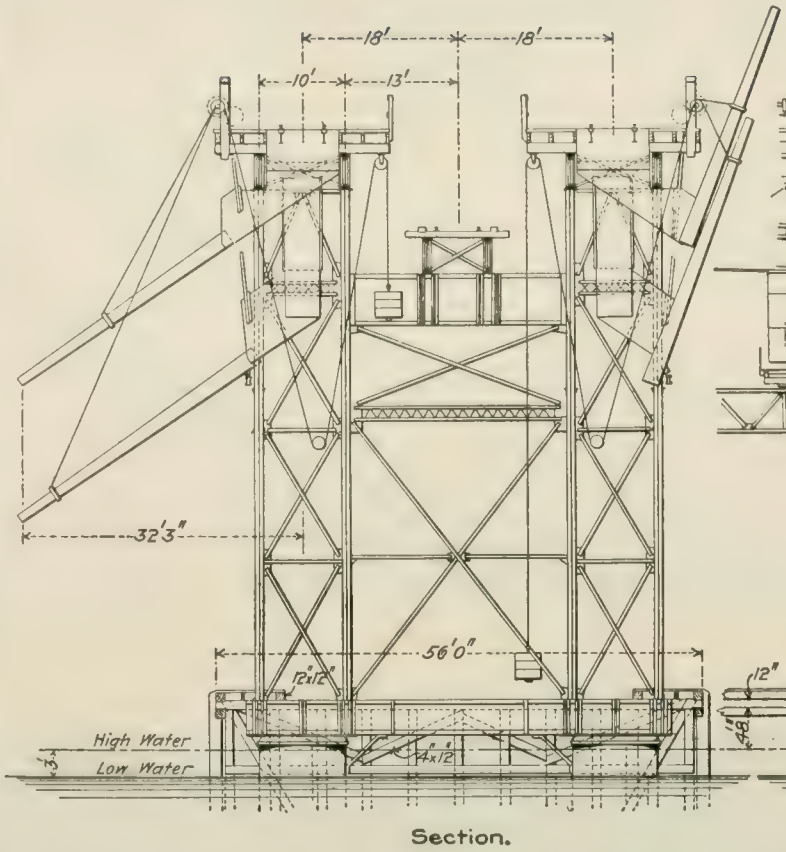
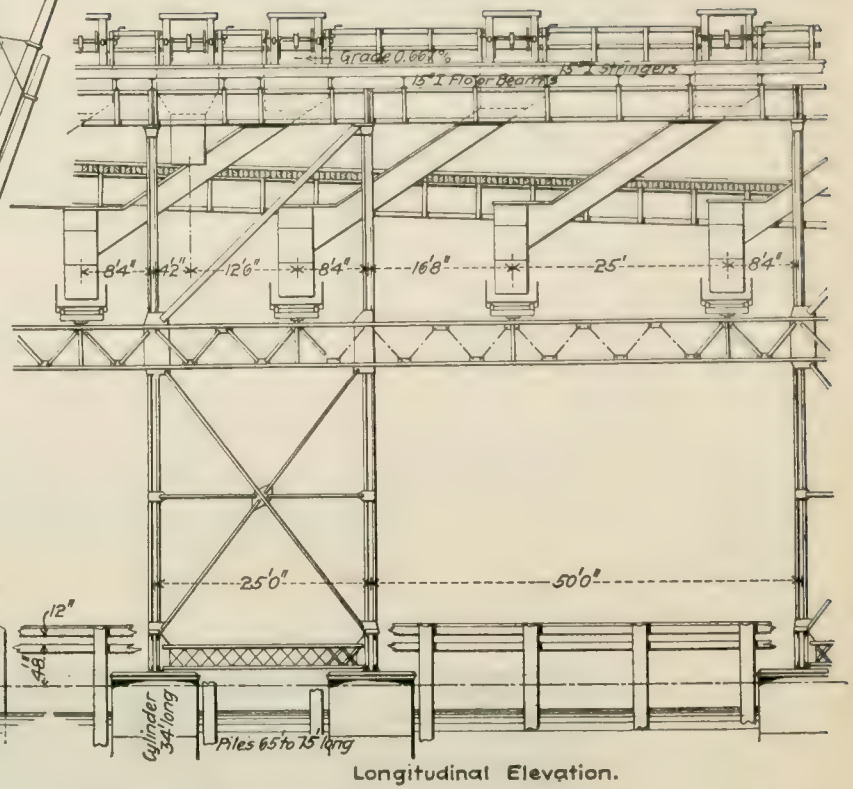


FIG. 20.—PLAN AND SECTION OF COAL PIERS AT LAMBERTS POINT, VA.; NORFOLK & WESTERN R. R.









G. 21-A.—HALF PLAN OF COAL PIER.

FIG. 21.—DETAILS OF COAL PIER AT LAMBERT'S POINT: N. & W. RY.

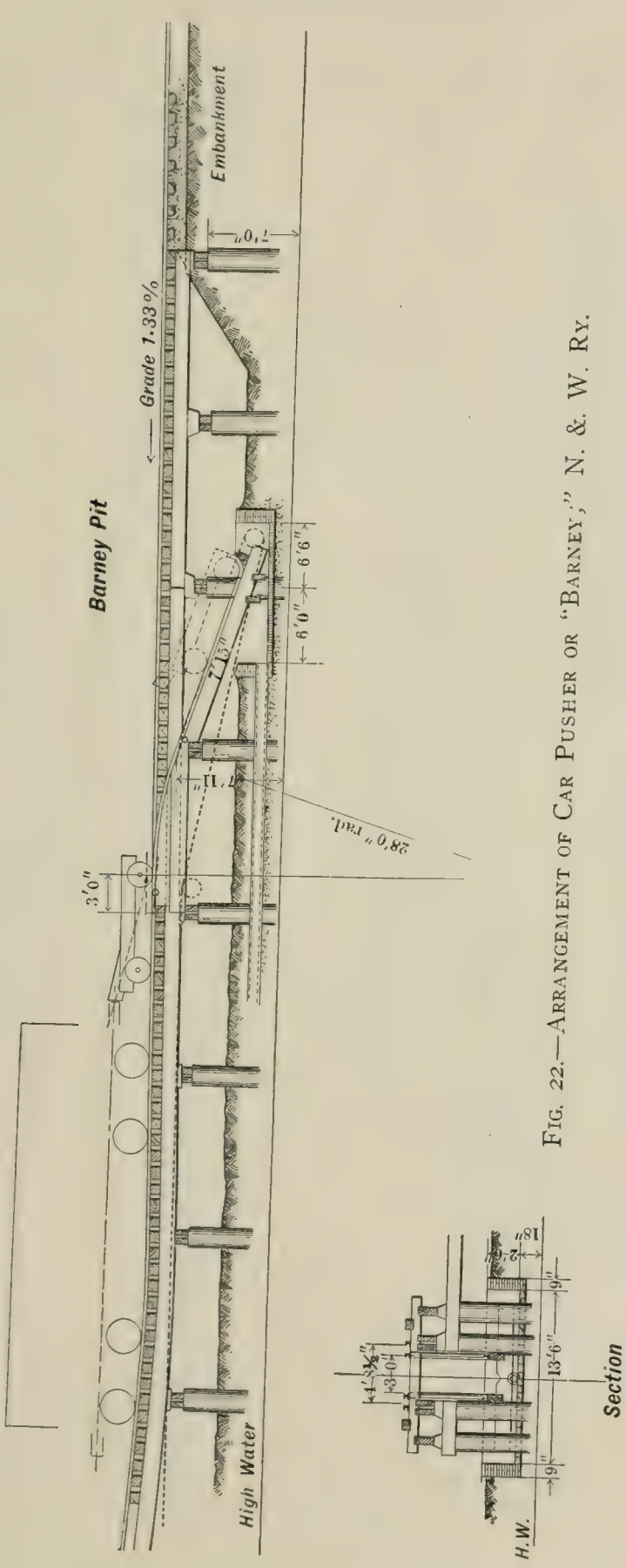


FIG. 22.—ARRANGEMENT OF CAR PUSHER OR "BARNEY," N. & W. RY.

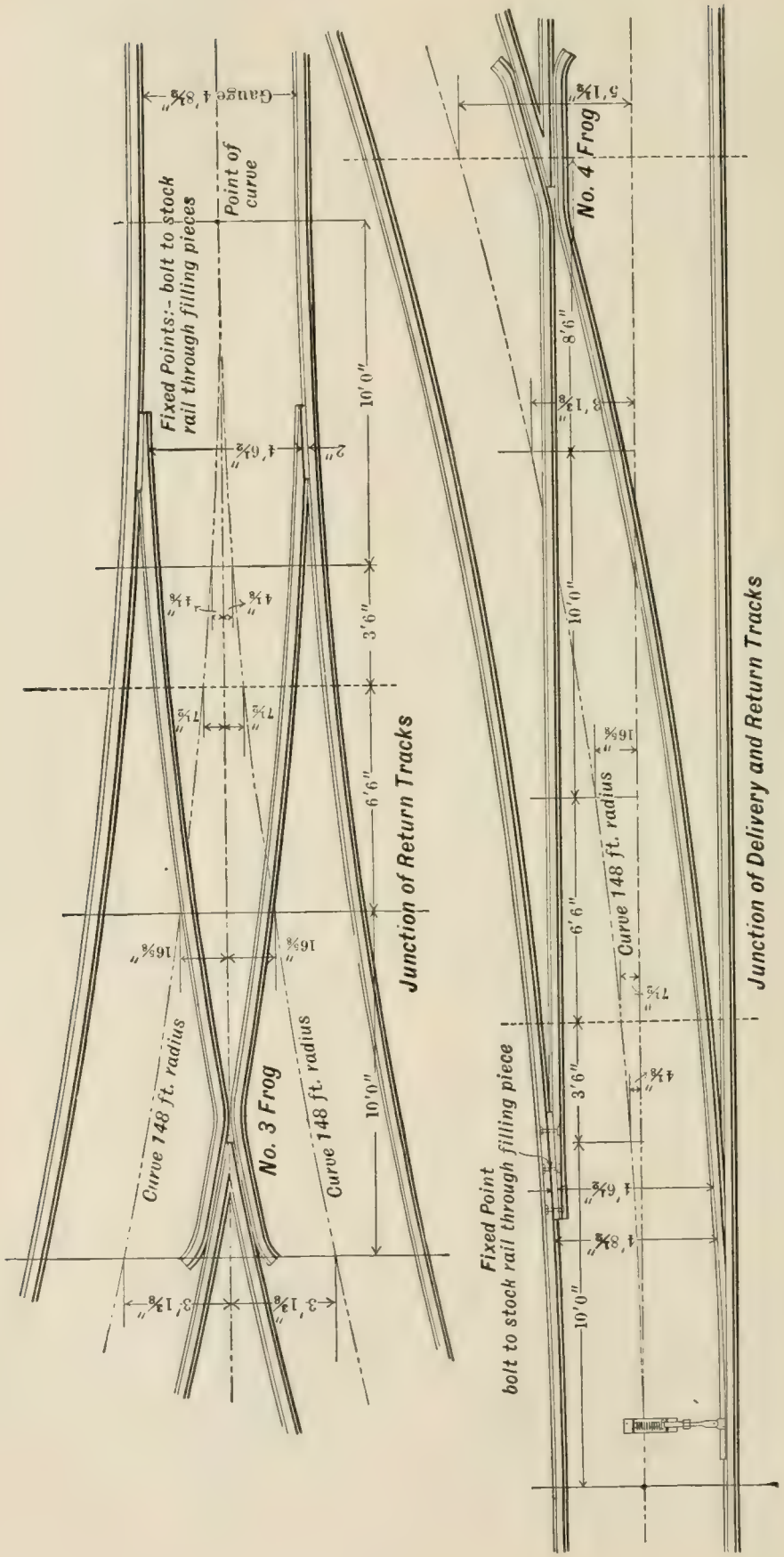


FIG. 23.—FROGS AND SWITCHES ON COAL PIER; N. & W. RY.

is because the chutes are long and carried on an incline at which the coal will naturally flow, so that the actual fall is dependent solely upon the depth of hold of the vessel being loaded, and the height of the pier has no real influence in the matter.

COAL-CAR DUMPING MACHINES.

For the rapid handling of coal (and ore) from cars to vessels machines have been introduced which pick up the loaded cars (containing 30 to 50 tons of coal each) and dump their contents at once. A number of these machines are noted in Appendix B. It has already been explained that in the handling of coal it is important to prevent its breakage into smaller sizes as far as possible, and, while a certain proportion of loss and breakage is inevitable, the car-dumping plants include special provision for reducing this to a minimum. This is done by preventing the coal from dropping or falling freely from any height. It is caused to slide or roll down inclined surfaces, and where vertical chutes are used they are kept so full that the coal "flows" rather than "falls" through them.

The McMyler Machine (McMyler Manufacturing Company, Cleveland, O.)—In the first machines built by this company the cars were dumped endways. The loaded car was hauled up an inclined girder forming a "see-saw" or "teeter-board," the outer end of which projected over the hatchway in the vessel's deck. The car being in position, and held by stops and clamps, the girder was then tilted to discharge the coal through the end of the car. The first machine was installed at Ashtabula, O., and another at Fairport, O.; both of these are still in service. These machines, however, necessitated the use of cars having end gates, and they have been superseded by the side-dumping machines, which can handle any style of coal car. The company has built fourteen machines and is now erecting at the Hoboken pier of the Delaware, Lackawanna & Western Railroad the first machine of this type for handling anthracite coal. This pier and its machinery equipment have already been described. A list of some of the piers equipped with these machines is given in Appendix B, and the four latest machines are located as follows: Cincinnati, Hamilton & Dayton Ry., Toledo, O.; Wheeling & Lake Erie Ry., Huron, O.; Pennsylvania Ry., Ashtabula, O.; Lake Shore & Michigan Southern Ry., Ashtabula, O. These machines were built under the supervision of Mr. F. W. Lovell, as Chief Engineer for the McMyler Company.

The style of the latest machine is shown in Fig. 24. It consists of a steel frame and the necessary mechanism for hauling cars in, elevating them and tilting them; also for moving the chute for delivering the coal into the vessels, and for clearing the vessels as they arrive at and leave the machine.

The operation is as follows: The loaded car is placed in the yard and moved to a point near the machine; this is usually done by gravity, but sometimes by an endless rope haulage system. The car is then hauled up the incline into the machine by means of a haulage engine. It is automatically clamped, hoisted to any desired height, and turned over sideways, delivering its contents into an inclined triangular apron, the car

being at the base of the triangle. The apron is adjustable as to height, to suit different vessels, and from its apex the coal runs through a vertical chute into the hold of the vessel. The coal simply slides down the apron, and as the chute is quite full the coal has no drop, but flows down in an unbroken stream. The chute is telescopic, so as to be adjusted to any height of the apron or any depth of hold. It is also pivoted, so that coal can be delivered at the sides as well as at the middle of the hold. The apron will hold 70 tons of coal, or two carloads. When the car has been dumped the cradle is lowered, and the car is pushed off by the next loaded car entering.

The machine is usually operated by steam power, and two steam winches are placed on the pier or dock for moving the vessel so that the different hatches will come under the chute. It is designed for handling either anthracite or bituminous coal, and provision may be made in the apron for screening the coal. The machine will handle all sizes of cars found in the coal trade (without any alterations), and will deliver coal into all kinds of vessels. When working under favorable conditions the machine can handle 30 cars or 1,000 tons per hour, and this rate has been attained with the machine of the Cincinnati, Hamilton & Dayton Railway at Toledo. The force required is given as follows: One man to operate the cradle and apron, 1 to operate the telescopic chute, 1 to operate the car handling machinery, 1 fireman, and 1 oiler.

The following is a description of the McMyler unloading plant of the Lake Shore & Michigan Southern Ry. at Ashtabula, Ohio. The plant consists of an unloader, its engine and boiler rooms, a properly designed system of tracks for loaded cars (built on a grade so that cars will run down to the unloader) and also a proper system of tracks for empty cars, built on such a grade that empty cars will run away from the unloader. The operation of the unloader may be described as follows: The loaded car starts down the grade from the loaded-car yard with a man riding the car. The car passes the unloader and runs down to and through a trailing automatic switch and then falls back down this incline, running towards the unloader and is immediately followed by a small pusher car or "barney" running on a narrow gauge track laid between the standard gauge rails. This pusher is under control of a man on the unloader. It pushes the coal car up a sharp grade to the unloader. On its way up the coal is thoroughly wetted from a tank located over the track. When the car reaches the unloader, it bumps the empty car off and down the grade to the empty-car yard. The loaded car takes the place of the empty one upon a cradle, which is then hoisted with the car. As the cradle is hoisted, the car is automatically shifted about six inches to the right so that the side of the car pushes against the side of the cradle. As the car rises still farther, the right hand side of the car engages a set of clamps which hold the car firmly down to the rail. As the car and cradle rise still farther, the cradle engages a stop at the right hand bottom side of the cradle, and the cradle with the car then begins to revolve about this stop. As the revolving motion proceeds, the set of clamps above mentioned, which hold the car to the rail, turn about a pivot

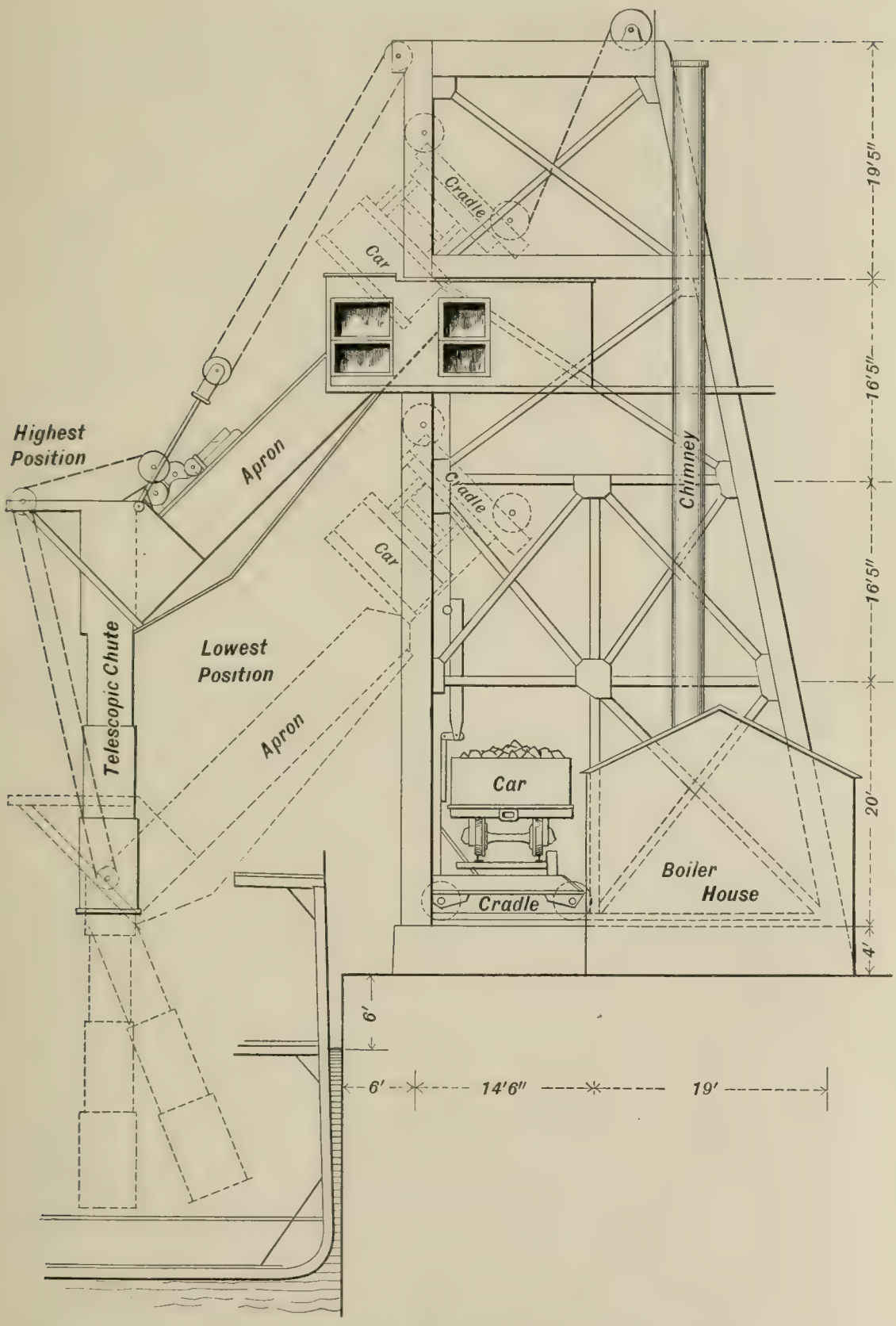


FIG. 24.—McMYLER COAL CAR DUMPING MACHINE.

just above the right hand upper edge of the car, and when the car has revolved far enough, these clamps engage also the left side of the car and thus securely hold the entire car to the rail. The car is revolved to the right until all of the coal is emptied into a large chute which extends the full width of the unloader. This chute rapidly tapers into a spout about four feet square, which is pivoted on the end of the crane in such a way that it can swing in a perpendicular plane at right angles to the unloader. The whole crane is raised and lowered by means of a block and fall, and pivots about its attachments to the unloader. When the vessel is in place and the hatches are open, the crane is lowered by the craneman, who, with a small engine, is located on the end of the crane, so that the spout is directly over the hatches. The spout is then extended down into the hold of the vessel and swung back and forth so that the coal is delivered to any part of the hold. The spout is built like a telescope for this purpose. The hatches of an ordinary steel coal vessel are 24 feet from center to center.

The crane and spout together are of sufficient capacity to hold an entire car of coal, so that the process of distributing a carload of coal in the hold need not delay the returning of the empty car. The crane is capable of another adjustment. Its pivot attachment to the unloader can be raised and lowered by means of perpendicular screws. The stop about which the cradle and car revolve moves with the crane in its up and down adjustment, so that the revolving cradle holds the same relative position to the crane in all positions of the latter. This latter motion is for the purpose of adjusting the crane to the different heights of the empty and loaded vessel. The car now being empty, the cradle revolves backward and is lowered, and as it reaches its place, the clamps are automatically released and the car is brought to its proper location, clear of the side of the cradle and in position to run down to the empty yard.

The next loaded car is then drawn up and bumps the empty car off the cradle, and the man who rode the first loaded car down to the unloader rides the same car empty down to the empty-car yard, which brings him back close to the loaded yard ready to take another car down. The unloader is operated with five men—one engineman, one fireman, two levermen and one craneman. The loaded and empty cars are handled by a conductor and five men, the latter riding the cars and the conductor keeping proper account of car numbers, etc. This plant was put into operation in June, 1903, and the men handling it are comparatively new at it. They average one car every three minutes, but if the cars had been brought to the unloader exactly as they were wanted, they could have handled one car every two minutes. It is, however, difficult to bring cars of different makes and from different distances to the unloader exactly on time. Some more complete method for supplying cars will have to be devised if the unloader is to be worked to its maximum. Some time was lost unnecessarily by the slow movement of the cradle with the return empty car.

The Brown Machine (Brown Hoisting & Conveying Machine Company, Cleveland, O.).—In this machine the cars are elevated and tilted

sideways to discharge their contents, but the car is not raised to a great height and the coal is not delivered directly into the hold of the vessel. The tilting cradle is mounted in a steel house or tower and the operations of the machine are as follows:

When the cradle is in its lowest and normal position, a loaded car is pushed into it by a pushing device ("a barney" or "ground-hog"), which lies in a pit between the track rails, when not in use, and is operated by a cable. When in the cradle the car is clamped by means of hydraulic clamping bars. The engine is then started and the cradle is slowly revolved sideways until the car is upside down. During this movement the coal has rolled, rather than fallen, from the car into six hoppers attached to the cradle, and each hopper has entered a transfer tub, or car, the six tubs standing on a flat car alongside the cradle. The hoppers have bottom doors, which are automatically released on touching the bottoms of the tubs. The cradle is then returned to its normal position, leaving the coal in the tubs, where it has been deposited quietly and without falling, so that there is practically no breakage. The empty car is then run out of the machine by gravity and another loaded car pulled in. In some cases cars can also be fed into the machine by gravity.

As soon as the cradle is clear of the tubs, the car on which they are mounted is hauled away and its place is taken by another car with six empty tubs. Running over the machine, on a runway parallel with the face of the pier, are two overhead steam traveling cranes, having a speed of 600 feet per minute. These have projecting girders extending beyond the face of the pier, but capable of being moved in and out, so as to clear the masts of vessels. These cranes, which are operated independently of the rest of the machine, take the loaded tubs, one by one, and carry them to a point opposite the proper hatch of the vessel, where they are run out on the girders and lowered into the hold. On touching the bottom of the ship or the top of the coal pile, the doors of the tub are released and the coal rolls out as the tub is hoisted out of the hold again. The crane operator then returns the tub to its car and takes the next tub, until all the tubs have been emptied. The machine operator then returns it to the dumping machine to have the tubs loaded again. The crane operator can dump the tubs in the center of the hatch, or at either side, and can carry the tub to any of the hatches, and can thus keep the vessel in proper trim all the time it is being loaded.

The two cranes can handle 5,000 tons in ten hours, and the car-dumping machine can handle twice this amount, so that by the use of four cranes the plant would have a capacity of 10,000 tons in ten hours. In 1903 one of the machines at Toledo, with two cranes, loaded 6,300 tons into a vessel in ten hours.

The machines were first built to handle 30-ton cars, but have since been strengthened to handle 40-ton cars, and those now being built are to handle 50-ton cars. The track layout and the construction of the pier vary, of course, with different conditions and locations. In some cases it is possible to feed the cars to the cradle by gravity and also to deliver them from the cradle by gravity; in other cases it is

necessary to use a car-pushing device or "barney" to feed the cars into the cradle. The company has built a number of these machines for dumping coal cars and ore cars. (See Appendix B.)

The Wellman-Seaver-Morgan Machine (Wellman-Seaver-Morgan Company, Cleveland, O.).—This company has for the last two or three years been building car-dumping machines almost exclusively for inland furnaces for iron ore, but has built one machine for handling coal. It is situated on the Buffalo, Rochester & Pittsburg Ry. dock at Buffalo. On this dock the coal to be handled was of such a nature that it was very essential to reduce the breakage to a minimum. For this reason the machine was built with large conveyor buckets, which carry the coal from the machine and lower it to the bottom of the hatch before dumping. Ordinarily, where it is not desired to look after the breakage so carefully, the machines are built with a chute, which conveys the coal from the machine direct to the boat.

The buckets are designed with a movable bottom, and when in position for receiving coal from the car dumper the bottom is close to the top of the bucket. As the bucket is filled the bottom gradually lowers so that the coal does not drop at all. After the bucket is filled it is conveyed over the hatch and lowered to the bottom of the boat, where the top part of the bucket is drawn away from the bottom, allowing the coal to flow out without any breakage. This is illustrated in Fig. 25. Two buckets only are used, their combined capacity being ample for any coal cars now in use. The general construction and arrangement are shown in Figs. 25 and 26.

The car dumper proper is very similar to the McMyler machine and was invented by Mr. G. H. Hulett. The loaded cars are run into the machine by a barney car, which disappears in a pit and allows the loaded cars to pass over and in front of it, when by a haulage engine it is pulled out and pushes the loaded car on to the platform of the car dumper. The car is automatically clamped to position on the platform by means of counterweights, which are hung on chains at the back side of the machine, the chains running through the machine and over the car. The weights are graduated so as to give a pressure sufficient to hold the car in an inverted position without putting an undue crushing strain on the sides of the car. The tracks which are provided for the car on the platform are arranged on a moving table, and the first motion of the car as it starts to invert is sideways, until the side of the car rests against the steel plates forming the side and chute of the cradle.

The machinery for controlling the tipple and conveyors is mounted on top of the machine. One operator is required for the tipple and barney car, one for each of the buckets, and a fireman. This car machine has handled 26 cars per hour, which is practically the same speed as the machines which dump directly into the boat. The result in regard to breakage has been found very satisfactory. The front end of the conveyors is made movable so that the two booms when extended over the boat may be placed over two adjacent hatches. These hatches are usually 24 feet centers. The total cost of running these machines, including

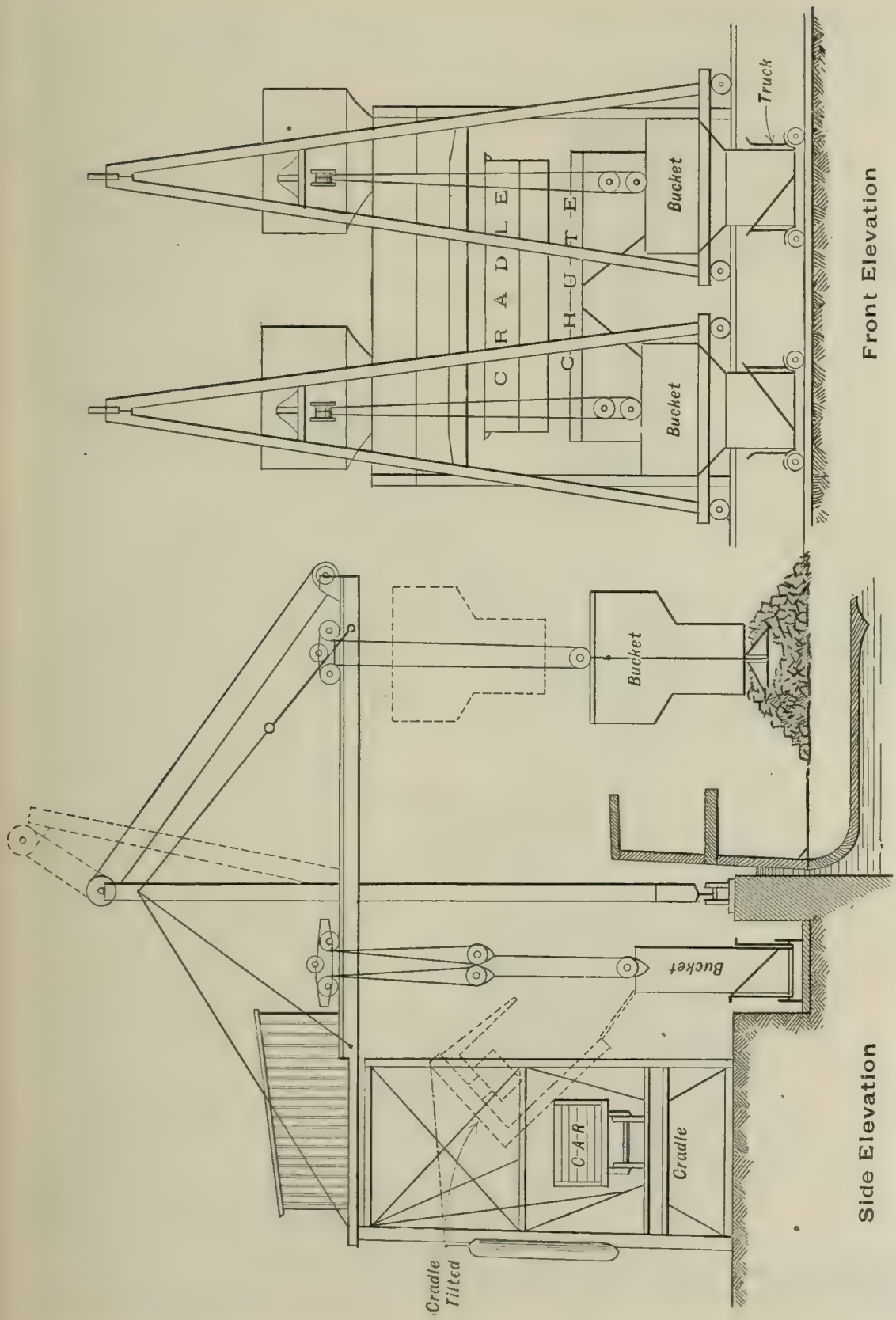


FIG. 25.—COAL CAR DUMPING MACHINE: WELLMAN, SEAVER & MORGAN CO.

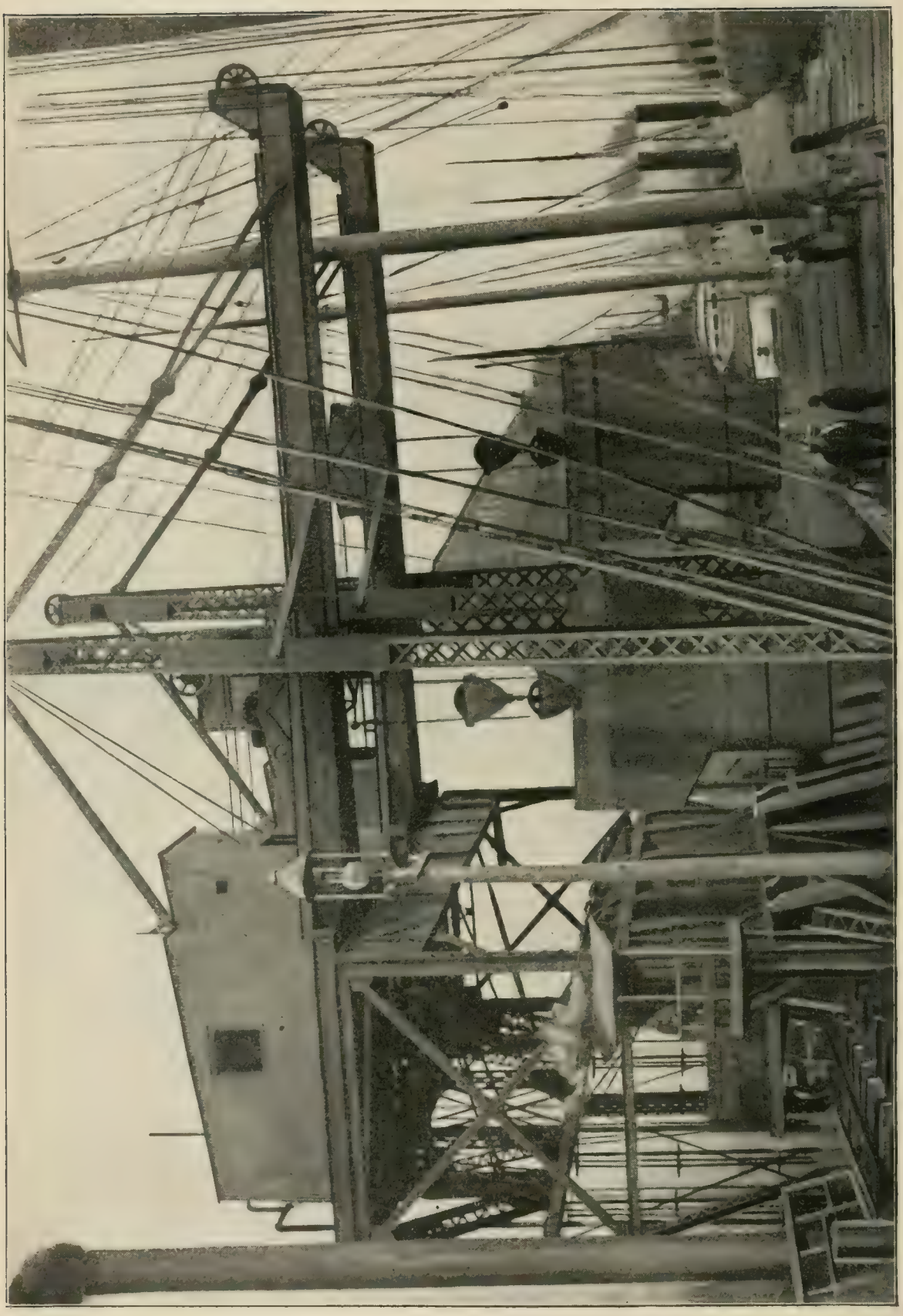


FIG. 26.—COAL HANDLING MACHINE.

shifting of cars, fuel, operators and maintenance, has been found to be from $550 to $600 per month. In ordinary use about 4,500 tons of coal are dumped over the machine during ten hours.

ADJUSTABLE COAL CHUTES.

In the handling of coal it is extremely desirable to prevent breaking it up, and breakage is often troublesome where coal is delivered through chutes and falls freely from a height into the hold of a vessel. In order to avoid this objection, the Link-Belt Engineering Co., of Nicetown, Pa., has devised an adjustable chute, sliding vertically and having its upper end connected to a vertical telescopic leg. The arrangement is shown in Fig 28. These chutes are in use at the new coal piers of the Pennsylvania Railroad at Greenwich Point, Philadelphia, Pa., and all the anthracite coal piers of the Philadelphia & Reading Railway at Port Richmond, Pa.

The following description is taken from an article in the Engineering News (May 28, 1903):

"On some important coal-shipping piers a new design of coal chute has recently been applied which represents an effort to reduce breakage of coal at a point where it is especially large in amount, viz., where it is loaded from railway cars into vessels. The coal reaches the piers from the mines in hopper-bottom gondola cars, and thence drops into a chute discharging through the hatchway of a vessel. On account of the greatly varying depth of hold and height of deck in different vessels, or in the same vessel in different conditions of loading, and also on account of the varying stage of the water in tidal estuaries, the chutes projecting from the pier out over the vessel must be constructed to suit the highest position of the largest ships. As a consequence, whenever a vessel in lower position is being loaded with coal, a considerable fall of the coal is unavoidable, and this results in a high rate of breakage even when auxiliary chutes, necessarily of steep slope, are employed. With the new type of chute, the inclined part of the chute is adjustable vertically to suit the height of vessel being loaded. Its slope is constant, and is only sufficient to allow the coal to move down; the chute is fed at its upper end from a vertical leg into which the hopper-bottom cars discharge, and a regulating gate at the upper end of the inclined portion serves to keep the vertical leg always full of coal. The coal is thus moved down the chute at a minimum velocity and with no free fall, and in this way a large part of the breakage is eliminated.

"These chutes are in position on an anthracite coal-shipping pier of the Philadelphia & Reading Railroad at Port Richmond, Philadelphia. At this point large quantities of coal arriving from the company's mines in eastern Pennsylvania are transferred to vessels for marine shipment. The vertical leg leading from this hopper is located at the edge of the pier, and on its outer face has a number of gates at different heights. The inclined chute, projecting out from the vertical leg, is adjustable in position up and down, and can be set opposite any one of the gates in the vertical leg. The chute is supported by chains, and is moved up and down by winding these on the winches above.

"A development of this form of adjustable chute is shown in Fig. 27. Here the vertical leg is constructed so as to virtually telescope as the chute is moved upward. The upper end of the inclined part is expanded into a receiving hopper which at all times forms the bottom of the vertical

leg. An installation of 40 of these chutes has been made at the Greenwich Point coal-shipping station of the Pennsylvania Railroad at Philadelphia. A new coal pier was erected there last year by the railway company, and to accommodate larger vessels than the existing piers it was designed very much higher than usual. The working of this type of chute will be readily understood from the drawing. The cut-off gate at the bottom of the main hopper may be used when it is desired to empty the vertical leg while the hopper is full of coal. This gate does not, however, serve for controlling the flow of the coal. A regulating gate for this purpose is located at the top of the inclined chute, where it serves to hold back the coal in the vertical leg, thus keeping the latter constantly full. The outer face of the vertical leg is formed of two plates, the outer one of which

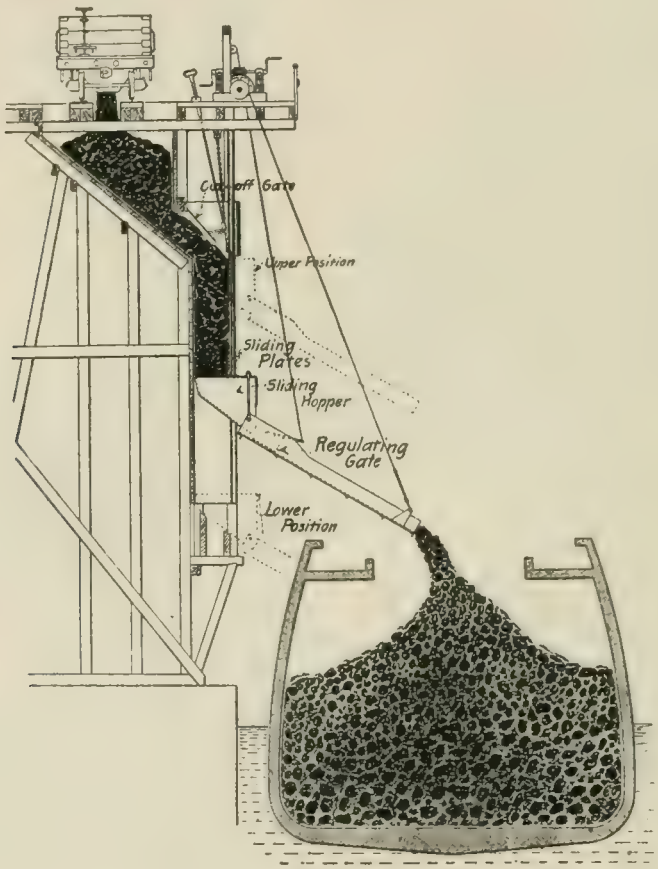


FIG. 27.—ADJUSTABLE CHUTE FOR COAL PIERS.

is fastened to the top of the inclined chute, while the inner one is fixed; these plates telescope over each other as the chute is moved up or down."

ORE PIERS.

The ore-loading piers of lake ports are in general similar to coal-loading piers. They consist essentially of long timber piers, extending out from the shore, with tracks along the top, on which the drop-bottom ore cars are run, discharging their contents through the floor into pockets Hinged chutes from these pockets deliver the ore by gravity to the hatchways of the vessels lying at the pier. The transportation of ore from the

Iron mines of Michigan and Minnesota forms the most important part of the entire freight traffic of the Great Lakes, and at several ports at the head of the lakes large piers are erected for loading the ore into vessels for transportation to the lower lake ports. According to a tabular list prepared by Mr. R. Angst, chief engineer of the Duluth & Iron Range Railroad, and revised to May, 1903, there are now 25 of these ore shipping piers, at eight ports, and owned by ten railway companies. Their total storage capacity is 958,620 tons. The largest of these ore piers is the No. 2 pier of the Great Northern Railway, at Superior, Wis., which is 2,100 feet long and has a storage capacity of 87,500 tons. Next to this comes the No. 2 pier of the Duluth, Missabe & Northern Railway, at Duluth, Minn.; this is 2,336 feet long and has a storage capacity of 69,120 tons. The third largest is the No. 6 pier of the Chicago & Northwestern Railway, at Escanaba, Mich.; this is 1,920 feet long and has a storage capacity of 58,000 tons. The general design of this pier is shown in Fig. 29, and its construction was described and illustrated in detail in Engineering News of July 30, 1903. As the matter of construction details of piers is not within the province of this Committee, the article itself is not included here. It will be seen from Figs. 28 and 29 that the pier has four tracks.

In regard to the list of ore piers, Table No. 2, it may be noted that many of the piers have been rebuilt since their original construction. These include all the piers of the Chicago & Northwestern Railway, and the new pier No. 6, above noted, takes the place of the old No. 2 pier. The Duluth & Iron Range Railroad has rebuilt piers Nos. 1, 2 and 4; No. 3 will be rebuilt in 1904, and No. 5 probably in the winter of 1905-6. The piers of the Duluth, South Shore & Atlantic Railway, and those of the Wisconsin Central Railway have been rebuilt. The others are the original piers. Most of the piers have a row of pockets on each side, but pier No. 1 of the Duluth & Iron Range Railroad has 1,076 feet of double pockets and 312 feet of single pockets. The angle of inclination of the pockets ranges from 38 degrees 40 minutes to 50 degrees 45 minutes, but the majority have an angle of 39 degrees to 45 degrees.

The ore piers are operated as follows: The loaded cars are hauled on top of the pier in trains of 30 to 45 cars, and are spotted in position over the pockets with relation to the various grades of ore. The ore is dumped into the pockets and the empty cars are hauled back into the outgoing or empty-car yard. The cars are 24 ft. between centers of couplings; the pockets in the ore piers are 12 ft. center to center of walls, measured parallel to the axis of the dock. The deck of the pier is level and the cars are hauled in solid trains to and from the pier proper. The approaches are preferably level; the maximum grade of approach at piers of the Duluth & Iron Range Railway is 0.5 per cent. against the loads. There are no gravity return tracks.

The cars are weighed empty about every three months, and always after heavy repairs. The light weight is then stenciled on the side sills. Loaded cars are weighed in full trains, coupled up and pulled by road engines over the scales at about ¾-mile per hour. The weight is re-

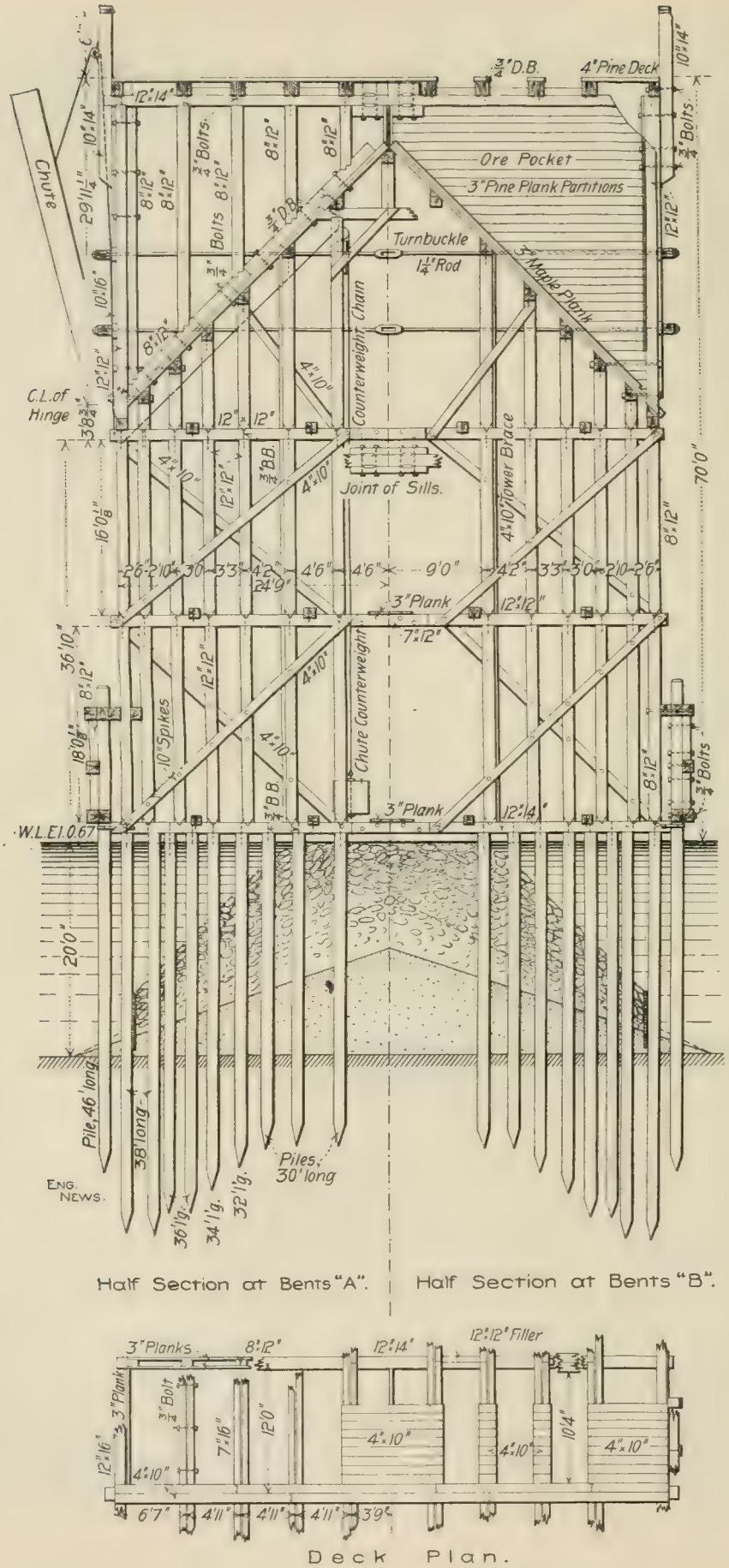


FIG. 28.—SECTION AND DETAILS OF ORE DOCK.

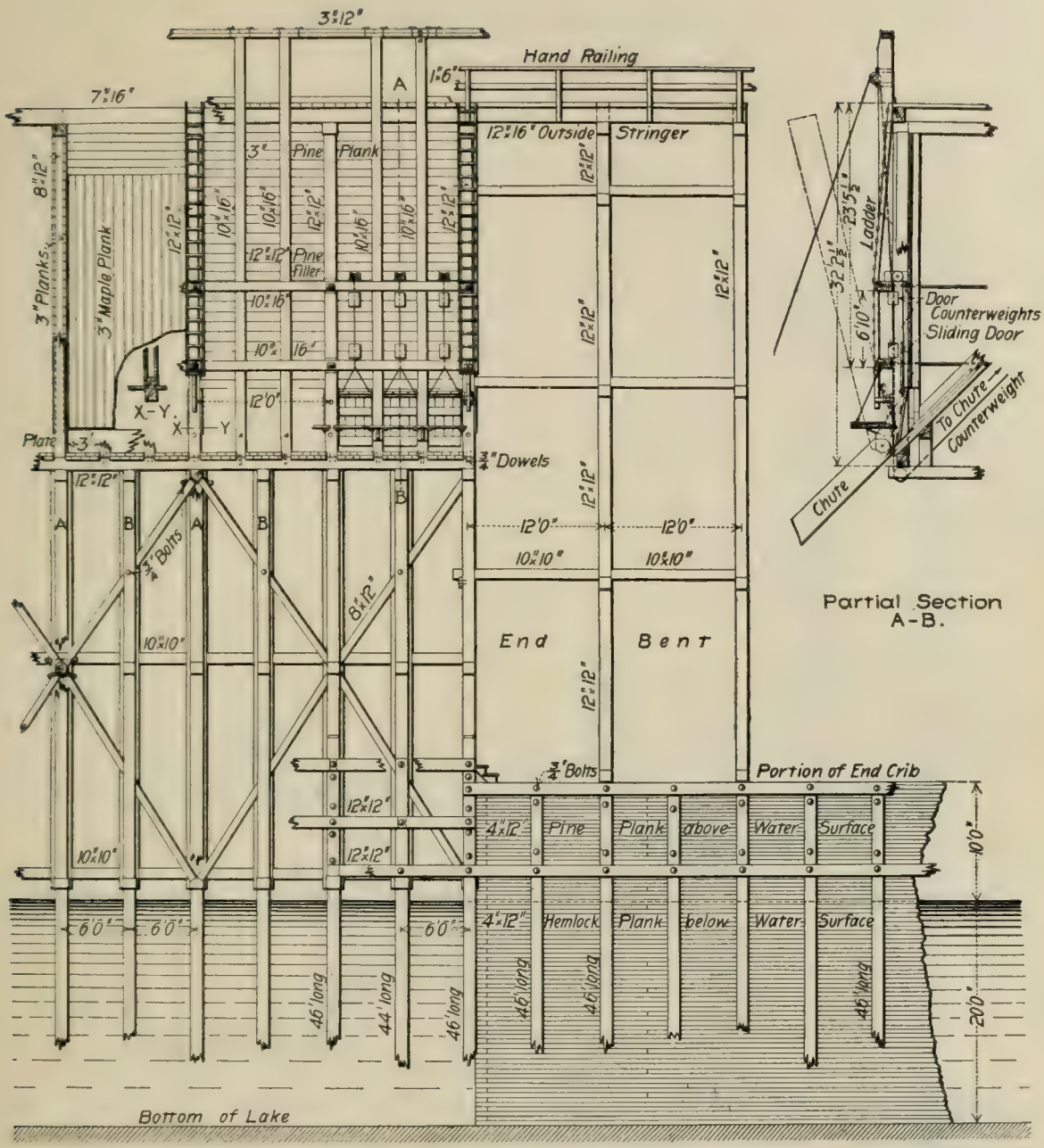


FIG. 28-A.—DETAILS OF ORE DOCK.

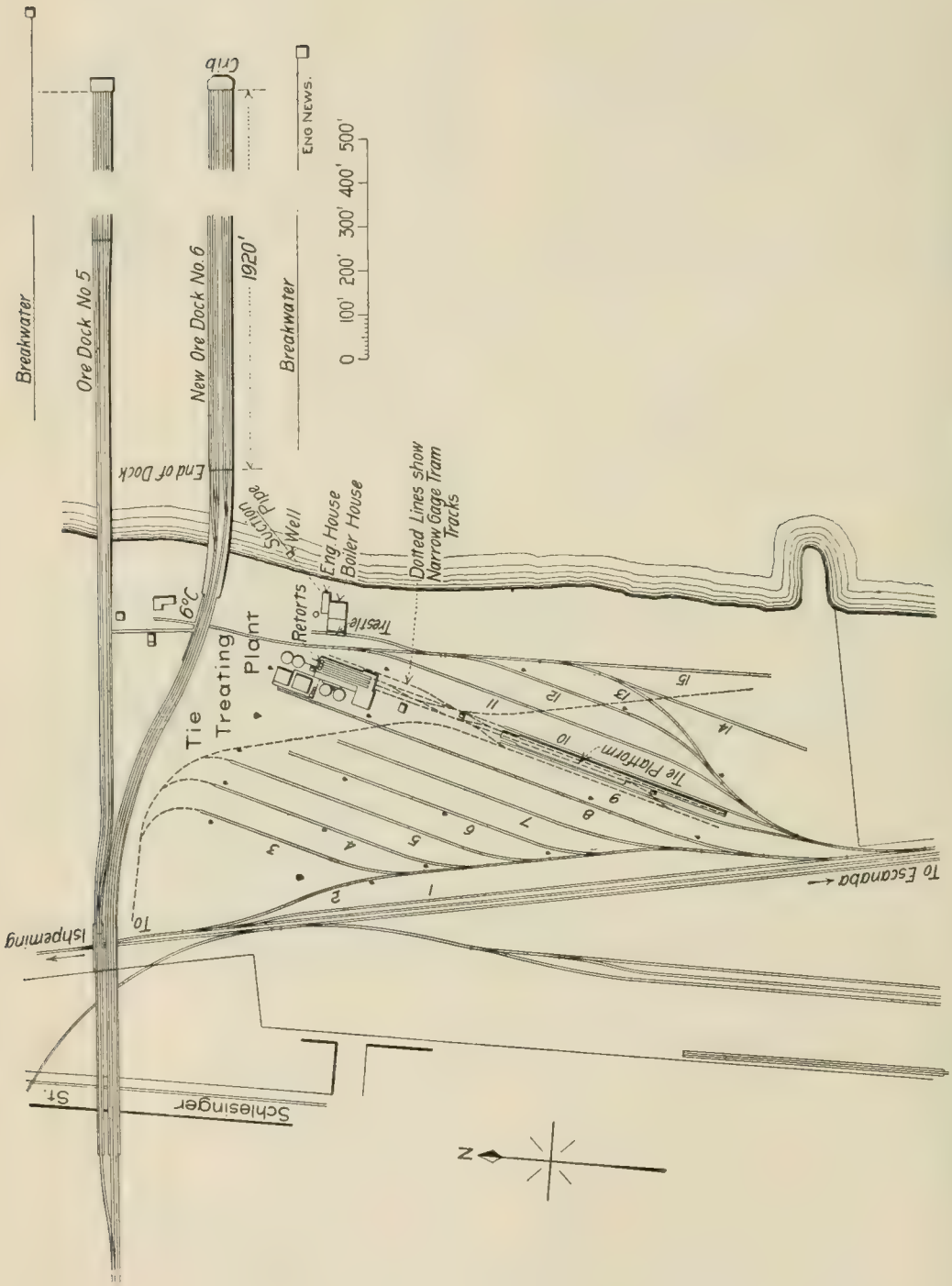


FIG. 29.—PLAN OF ORE DOCKS AT ESCANABA, MICH.; CHICAGO & NORTHWESTERN RY.

TABLE II.—IRON ORE SHIPPING PIERS ON THE GREAT LAKES.

RAILWAY.	Location.	Pier No.	No. of Pockets.	Storage Capacity, Tons.	Length of Pier.	Height from Water to Hinge of Chute. ft.	in.	Height from Water to Deck ft.	in.	Width over Partition Posts. ft.	in.	Length of Spouts. ft.	in.	Angle of Pockets. deg.	min.
Chicago & Northwestern	Escanaba, Mich	1	184	24,104	1,104	28	10	48	6	37	0	21	0	39	30
" "	" "	3	220	30,284	1,356	31	2	52	8	37	0	27	0	45	0
" "	" "	4	250	32,750	1,500	36	6	59	2	37	0	30	0	45	0
" "	" "	5	232	43,152	1,392	28	6	53	3	37	0	21	8	40	0
" "	" "	6	320	58,000	1,920	40	0	70	0	50	2	30	0	45	0
" "	Ashland, Wis	1	234	36,036	1,404	32	10	54	0	46	8	27	0	39	30
" "	" "	2	234	25,740	1,404	36	6	57	8	46	0	27	0	42	0
Total				250,066											
Duluth & Iron Range	Two Harbors, Minn	1	202*	40,400	1,388	35	5	59	6	49	0	27	0	38	42
" " "	" " "	2	208	41,600	1,280	33	5	57	6	49	0	27	0	38	42
" " "	" " "	3	90	16,200	572	28	10	52	0	49	0	25	0	38	42
" " "	" " "	4	168	36,960	1,112	37	0	62	0	49	0	29	0	38	42
" " "	" " "	5	168	33,600	1,112	30	0	54	6	49	0	25	0	38	42
Total				168,760											
Duluth, Missabe & Northern	Duluth, Minn	1	384	57,600	2,336	30	0	53	0	49	0	27	9	45	0
" " "	" "	2	384	69,120	2,336	32	0	57	6	49	0	27	9	45	0
" " "	" "	3	192	40,320	1,152	40	7	67	0½	59	0	27	9	45	0
Total				167,040											
Duluth, South Shore & Atlantic	Marquette, Mich	1	270	27,000	1,700	25	0	45	0	40	0	20	4	39	0
" " "	" "	4	200	28,000	1,200	27	9	47	3	36	8	21	1	39	45
Total				55,000											
Lake Superior & Ishpeming	Marquette, Mich	1	200	36,000	1,232	30	9	54	0	50	0	24	7	38	40
Great Northern	Superior, Wis	1	250	40,500	1,525	32	0	57	0	49	8	27	2	45	0
" "	" "	2	350	87,500	2,100	40	0	73	0	62	8	32	4	45	0
" "	" "	3	160	40,000	960	40	0	73	0	62	8	32	4	45	0
Total				168,000											
Minn., St. Paul & S. S. Marie	Gladstone, Mich	1	120	15,000	768	26	8	47	0	37	0	21	8	40	0
Wisconsin Central	Ashland, Wis	1	314	48,356	1,908	40	0	66	2	36	0	27	0	50	45
Chicago, Milwaukee & St. Paul	Escanaba, Mich	1	240	50,400	1,500	40	2¾	66	6	52	0	27 & 29†		45	0
Algoma Central & Hudson Bay	Michipicoten, Ont.	1	12	.....	312	34	0	43	4	25	0	22	6	41	0

*No. 1 Pier, D. & I. R. Railroad, has double pockets for 1,076 ft., and single pockets for 312 ft.
†The pier of the C., M. & St. P. Ry. has 120 spouts 27 ft., and 120 spouts 29 ft. long.

corded automatically on a paper tape; the light weight of the empty car is set off on an auxiliary scale beam, and the reading gives the weight of the contents. The scales are tested and balanced daily by the weigh-master, and once a month by the manufacturer, with his own test weights. Comparative tests of individual cars, standing on the scales, uncoupled, are made between automatic and hand weighing at the regular ore scales and on an extra set of scales of double capacity. All ore scales are of 100 tons capacity. The details of weighing are of importance, because the railway weights are accepted as the basis not only of the freight charges for rail and vessel transportation, but also for the royalty to be paid by the lessees or operating companies to the fee owners.

ICING STATIONS.

Icing stations are generally installed at such terminals or junction points as the necessities of the traffic require. They should, if possible, be so located as to make them most readily accessible for prompt move-

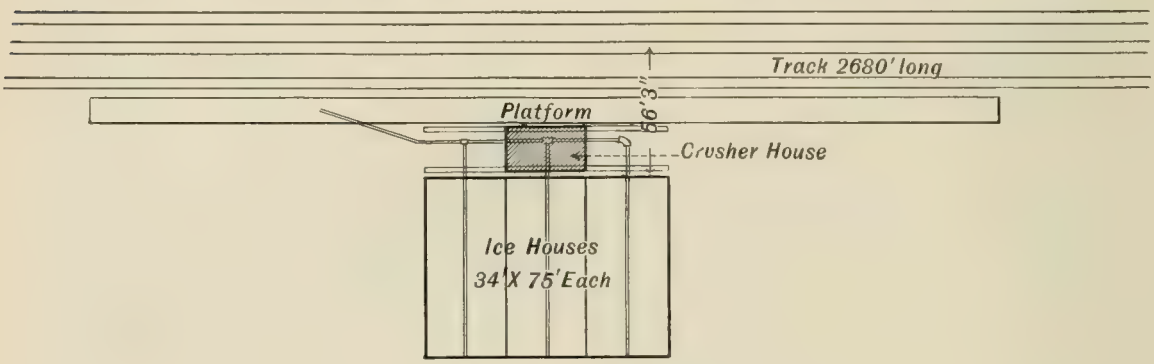


FIG. 30.—ICING PLANT; LAKE ERIE & WESTERN RY.

ment, so that the minimum time shall be consumed in placing of traffic to the icing station for necessary attention. The tracks should be so arranged that the movement to the icing station from the general yard, or cluster, or from the main track, may be made without interference with the general yard or main line movement. The location of the ice house should be convenient to the course taken by through cars in passing through the yard, and preferably near to the repair tracks.

Your Committee has thought it well to present a description of the icing plant built by the Lake Erie & Western Railroad at Tipton, Ind., as a good example of its class. The plans here submitted (Figs. 30 to 34) indicate what may be generally followed, and which, in the opinion of the Committee, will give satisfactory results.

This station is for icing refrigerator trains at Tipton, Ind., which is the junction point of the main line and the Indianapolis and Michigan City Division. Tipton is located about half way between Sandusky, O., and Peoria, Ill., the terminal points of the main line. The total length of the main line is 416 miles.

An icing station designed for the icing of refrigerator cars in transit embraces many important features, the most important being capacity

and construction of storage house; method of handling ice to and from the house and through the crusher; and promptness and economy in handling ice in and out, and the icing of trains. In this plant the above features have been very carefully considered.

CAPACITY AND CONSTRUCTION OF STORAGE HOUSE.

The storage house has a capacity of 6,000 tons. It consists of three compartments, each 34x75 ft. and 36 ft. high from floor to top of wall plate. The exterior walls are constructed of 3x12-in. studding, 36 ft. in length, spaced about 24 ins. on centers and lined on the inside with ⅞-in. boards. This entire surface is covered with No. 2 roofing felt. Then comes a second or inner row of 2x8-in. studding, spaced about 24 ins. on centers, to which are nailed ⅞-in. boards, forming the inner lining of the wall. Between this inside lining and the studding there is placed a layer of No. 2 roofing felt. This makes an inside chamber 8 ins. in width, which is lined up both sides with felt and filled with pine sawdust, the filling being done from the top after the building is practically completed.

The space between the outer or 3x12-in. studding forms an air chamber, which is ventilated through the wall plate by three 2-in. holes to each space between studding. This allows the warm air to rise through the wall plate and on up to the space between the main and false roofs and then through the roof ventilators. This gives a very perfect system of ventilation to the walls of the building. More or less air works in through the outer siding, and as it becomes heated it rises, so that during the daytime there is always a very perceptible draft through the holes in the wall plate.

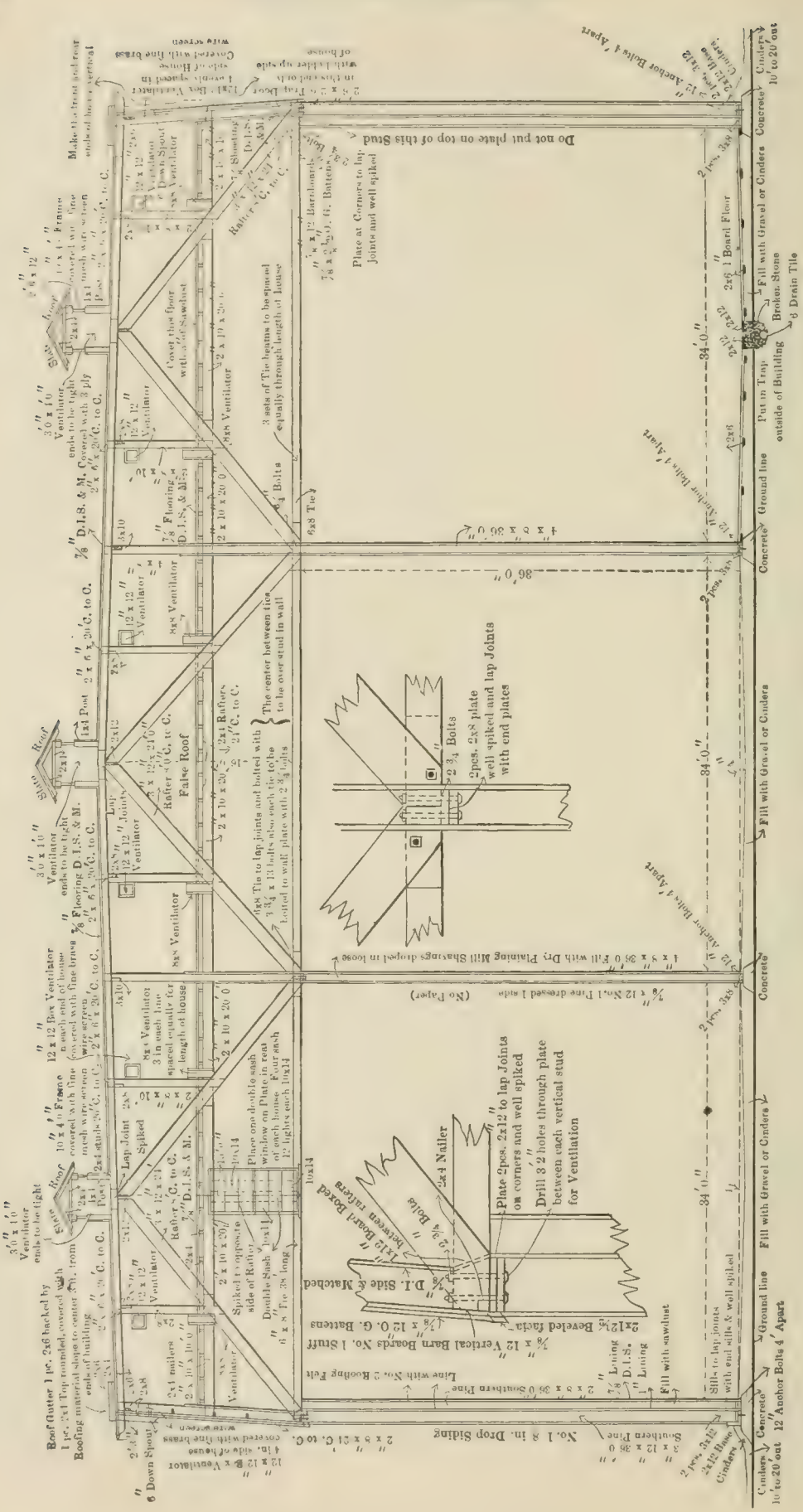
The floor is constructed of 1-in. boards nailed to 2x6-in. stringers, The floor boards and the stringers rest on a bed of cinders. The floor slopes toward the center, making the center 4 ins. below the side walls. The same slope is given at the ends. The object of this is that the ice will have a tendency to run toward the center rather than against the walls.

The false roof is level and is 7½ ft. below the main roof at the center of the building. It is supported on the main rafters. The covering is ⅞-in. flooring, dressed one side and matched. On this false roof is spread a layer of three to four inches of sawdust.

Through the false roof there are six 8x8-in. ventilators over each compartment of the building to ventilate the storage compartments. The space between the main and false roofs is ventilated by three raised ventilators 3x4 ft., and a system of side and end wall ventilators 12x12 ins. in size placed about two feet below the main roof. Of these there are six in each side and four in each end. They are covered with fine meshed brass wire screens to prevent sparks from engines getting into the building.

ELEVATOR AND CRUSHER HOUSE.

This house is 18x36 ft. and 36 ft. in height. It rests upon a track which runs parallel to the front of the building. The track is supported on 12x12-in. oak stringers, resting on concrete piers. The house rests on


Do not put plate on top of this Stud
Plate at Corners to lap Joints and well spiked
Fill with Gravel or Cinders
Put in Trap outside of Building
Broken Stone
6 Drain Tile
Ground line
Concrete
Cinders
Anchor Bolts 4' Apart
Fill with sawdust
Line with No. 2 Roofing Felt
No. 1 8 in. Drop Siding
Southern Pine
Lap Joint Spiked
Double Sash 1x11
Place one double sash window on Plate in rear of each house. Four sash 12 lights each 10x14
Spiked to opposite side of Rafter
Rafter 2'6" C. to C.
Ventilator
Roof
Roof Gutter 1 pc. 2x8 backed by 1 pc. 2x4 Top rounded, covered with Roofing material sloped to center (No. from ends of building
Ventilator ends to be tight
12 x 12 Box Ventilator 10 x 4 in Frame Louvre boards covered with fine brass wire screen
Louvre boards covered with fine brass wire screen
Make the front and rear outside of heavy vertical
Cinders 10 to 20 cut
Concrete
Fill with Gravel or Cinders
Ground line
12" Anchor Bolts 4' Apart
Cinders 10 to 20 cut
Concrete
Fill with Gravel or Cinders
Ground line
Sills to lap Joints with end sills & well spiked
Fill with sawdust
Line with No. 2 Roofing Felt
2 x 8 x 12 C. to C.
12 x 12 Ventilator
4 in. side of house
covered with fine brass wire screen
6 Down Spout
Southern Pine
2 x 12 Anchor Bolts 4' Apart
Cinders 10 to 20 cut
Concrete
Fill with Gravel or Cinders
Ground line
Put in Trap outside of Building
Broken Stone
6 Drain Tile
2x8 1 Board Floor
2x8
2x12 Plank
2x12 Anchor Bolts 4' Apart
Cinders
Concrete
Fill with Gravel or Cinders
Ground line
Concrete
Fill with Gravel or Cinders
Ground line
Concrete
Cinders 10 to 20 cut
2 pcs. 3x8
2 pcs. 3x8
2 pcs. 3x8

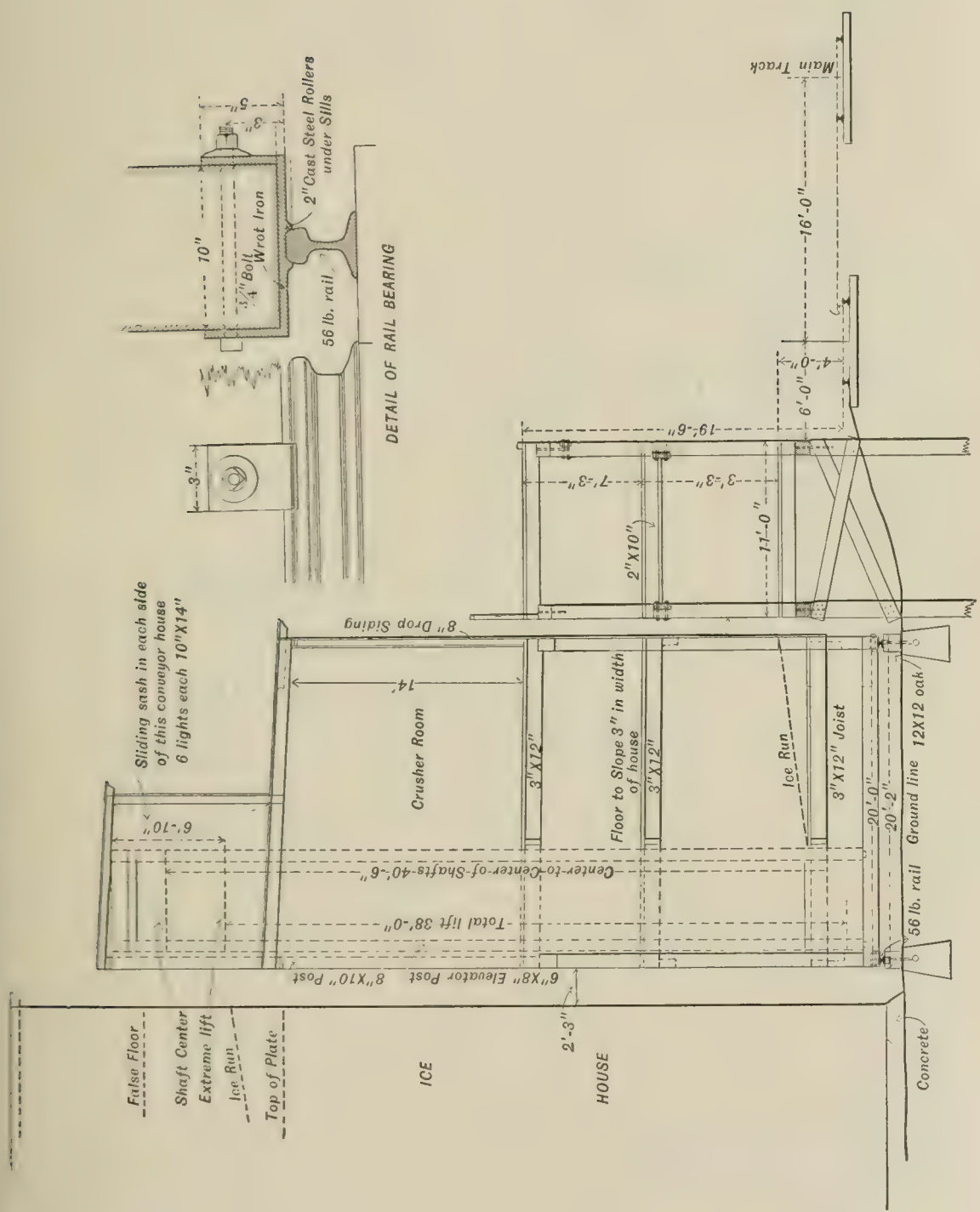


FIG. 32.—TRAVELING ICE-CRUSHER HOUSE.

cast steel rollers with double flanges, which fit over the rail, and it is easily moved from one compartment of the main storage house to another.

The elevator and crusher house is entirely a new feature. In most plants the ice is elevated from the storage house compartments and car-

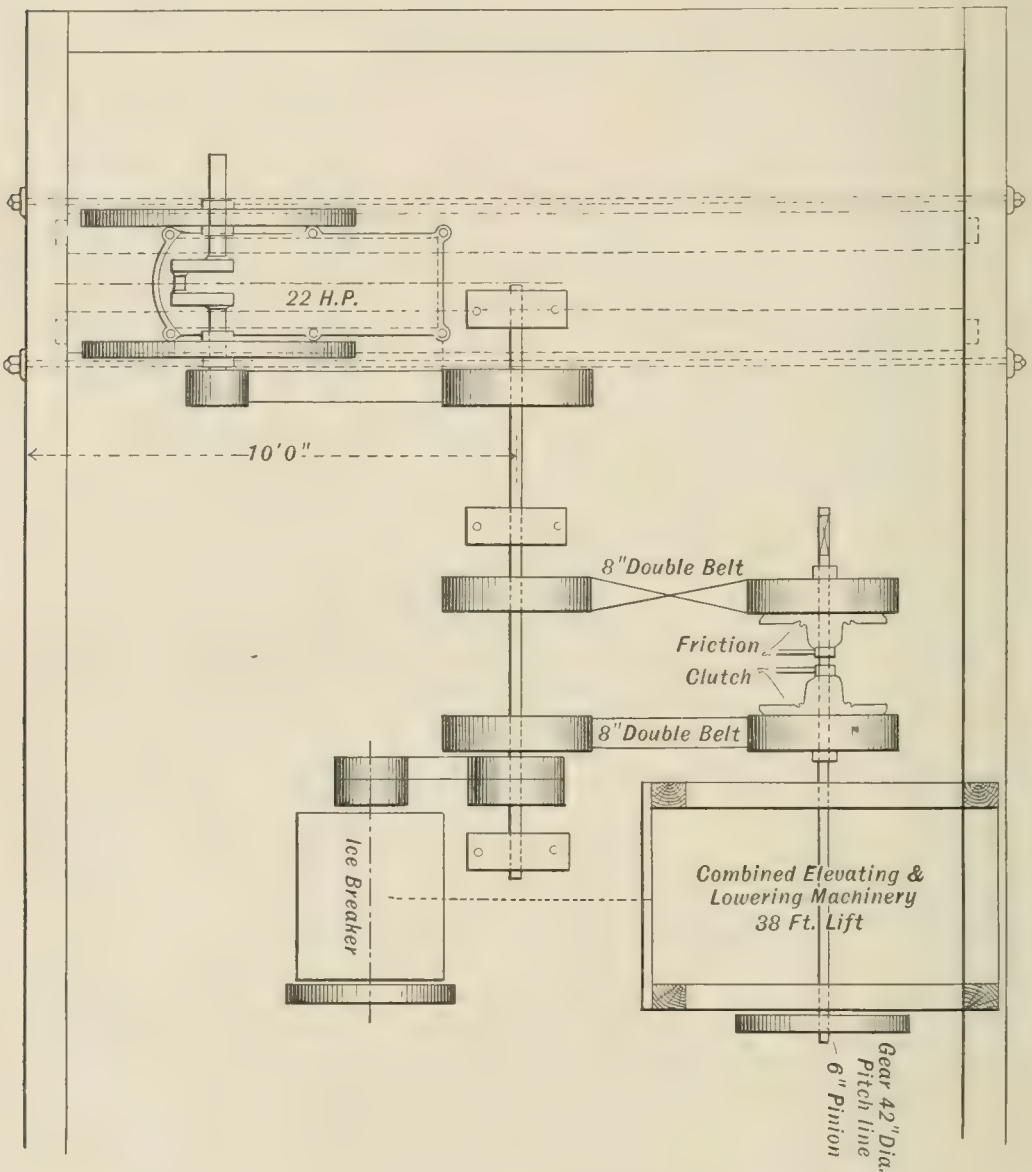


FIG. 33.—PLAN OF MACHINERY IN ICE CRUSHER HOUSE.

ried to the crusher, which is in a compartment by itself in the main building. This takes up considerable room and the ice storage houses have to be kept open a great deal of the time, which is an undesirable feature. Furthermore, it requires an elevator for each storage compartment. In the Tipton house there is no long shafting and only one elevating and lowering machine. The machinery is compact and entirely under cover.

The elevator and crusher house is divided into three floors. The

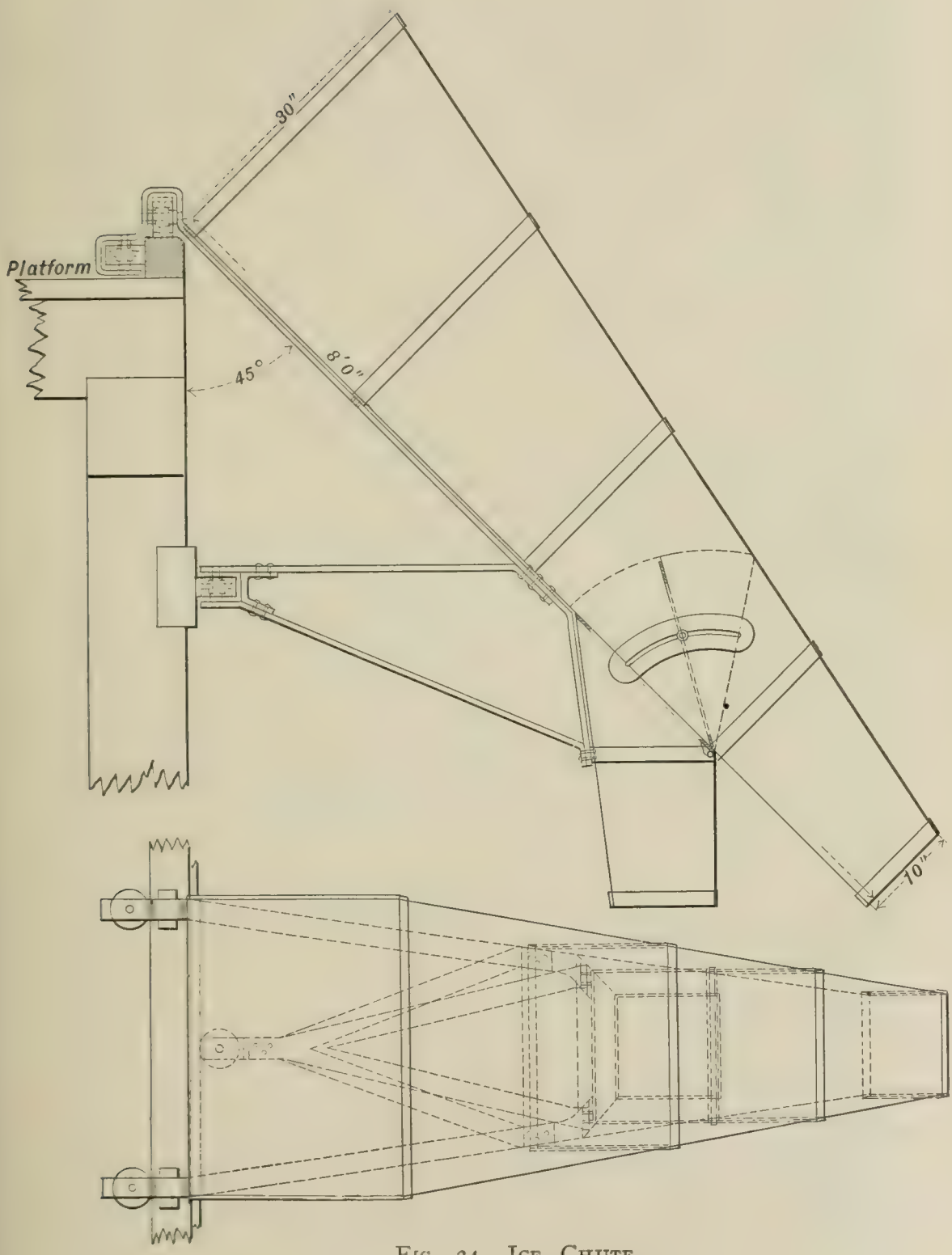


FIG. 34.—ICE CHUTE.

first is about 18 inches below the lower deck of the platform and car floor. On this floor is located the gasoline engine. The second floor is level with the middle deck or top of car and is used to receive cake ice from the storage house to be delivered to refrigerator cars in which cake ice is used. The third floor is level with the main deck of the platform, or about 7 ft. above the top of the car. On this floor is located the ice crusher. The crusher has a capacity of 27 tons and delivery carts with a capacity of 800 pounds are used in conveying the ice from the crusher to cars needing crushed ice. The elevating and lowering machine is located in the center of the side of the house towards the main building. It has a capacity of about 50 tons per hour.

The platform is constructed parallel to the loading track and 4 ft. from the nearest rail. The lower deck is level with the car floor and extends the full length of the main storage house. At one end is located the salt house, with a capacity of about 20 tons. The second or middle deck is on a level with the top of refrigerator cars. Salt boxes are located along the edge of this deck about a car length apart. The salt is used in connection with the crushed ice. The upper deck is 7 ft. above the middle deck. On this platform the ice is carted from the crusher to the ice chute, which is hung from the edge of the deck and which can be moved along from one car to another, as it runs on rollers. The ice is dumped from the carts through the chute (Fig. 34) into the refrigerator cars. The middle and upper decks of the platform are 408 feet in length and will admit of icing ten cars before moving of the train. Cake ice is handled from the elevator to the refrigerator cars on the middle or second deck.

In order to promptly ice trains, the foreman keeps himself posted through the telegraph operator as to when refrigerator trains are expected and about how many cars there are in the train. He then crushes enough ice to fill the delivery carts, providing there are enough cars in train to require them all to be filled. The floor on which the crusher stands will hold 30 of these carts.

RAIL AND WATER TERMINALS (PIERS).

(NOTE:—A further discussion of this part of the Committee's fourth annual report, which was accidentally omitted from the volume of Proceedings for 1903, is added to this present report as Appendix D.)

It will be remembered that the fourth annual report, submitted at the meeting of March, 1903, was referred back to the Committee for reconsideration of the conclusions respecting piers at rail and water terminals. Your Committee has reconsidered these conclusions, and has sought for additional light on the matter, but its requests have produced very little information or discussion from members.

In presenting the conclusions in amended form, the Committee desires to call special attention to the general clause on "Piers" which precedes the conclusions proper. The varying conditions and combinations of conditions which exist at different terminals of this class, and even at dif-

ferent parts of any one large rail-and-water terminal, make it out of the question to present any but the most general conclusions.

One special feature commented upon in the discussion of the last report was that of the length of pier. The Committee gave a length of 600 ft. as suitable under general conditions. This length takes in any kind of steamers and works out fairly well to the average length of carfloats and lighters, etc. A 400-ft. pier could not be used for export with the larger boats. In many cases a pier 1,400 or 1,600 ft. long could be used to advantage, and piers up to 1,300 ft. in length are actually in use. The arguments advanced for a length of 600 ft., however, do not prevent making the pier as much longer as any company may consider desirable for its own use. The city of New York has desired to build piers 1,000 ft. long to accommodate the transatlantic steamer lines, as noted in Appendix A. At Galveston is a cotton and freight pier 1,300 ft. long, and many ore piers on the Great Lakes are 1,000 to 2,300 ft. long, but the conditions governing ore piers are, of course, very different from those which govern freight piers.

Relative to the width, each foot that is added to the width means just one more foot of extra trucking. In most cases in New York harbor it would be almost impossible to get piers as wide as recommended by the Committee. That width was decided on as about the best width for economical handling. If a greater floor area is required than can be had in this way, it then becomes a question as to whether a wider pier is better than building two of the houses described in the report. In that case it would in general be preferable to widen out the house, if possible.

It must also be remembered that the warehouse, as designed, is built for two purposes, handling both inbound and outbound freight, and that the essential feature of the outbound part is that a large number of carfloats can be end up at the bulkhead. To add to the width of the house tends to decrease the ability to handle outbound freight. Piers of 250 ft. in width have been built at Brooklyn, N. Y., and the Gulf, Colorado & Santa Fe Ry. has at Galveston a pier 1,300x575 ft.

The Committee has investigated this matter of pier dimensions and in Appendix A presents the results, showing the size and arrangement of existing piers at different ocean terminals. Among these will be noted a combination coal and freight pier of the Louisville & Nashville Railroad.

In closing its remarks on the subject of the dimensions of piers, your Committee quotes the following remarks from a letter by Mr. W. J. Wilgus, Fifth Vice-President of the New York Central & Hudson River Railroad, accompanying the plans of the New York water terminals of that company, which are referred to in Appendix A:

"In reference to the best dimensions for piers and arrangement of tracks, it is very doubtful whether general rules can be laid down that will be of value and which are not liable to be misleading, owing to the variety of requirements not only in different harbors, but at different terminals in the same harbor. For example: In New York Harbor, westbound freight requires but little storage, and from 25 to 35 ft. from the string piece to the track in covered piers for this class of freight is very good. On the other hand, eastbound package freight requires storage, in some cases for a considerable length of time.

"The character of the freight to be handled, the method of tiering, and the extent to which carloads are to be kept separate, must all be considered in deciding on the width at each individual terminal.

"As to the width of open piers; the question of whether storage is required or not, and whether the pier is to be equipped with traveling cranes, are the controlling conditions.

"As to the dimensions suggested by the Committee, in its fourth report, it is safe to say, from the experience at the terminals of this company, that the length of 600 ft. can be taken as a minimum, and that piers of twice that length can be operated to advantage; provided, of course, that the slips are of proper size, and the yard design permits of properly handling the cars.

"The suggested width of covered piers of 125 ft. is too wide for strictly westbound service (75 ft., with two tracks being near the requirements); but it is too narrow for eastbound export piers, which should be from 150 ft. to 200 ft., depending upon the conditions referred to above.

"A combination of eastbound and westbound and transfer freight, of course, requires still different dimensions.

"It is doubtful whether an open pier should be less than 45 ft. wide with three tracks, and 60 ft. with four tracks is preferable; provided storage is not required. On the other hand, it is doubtful whether ordinary storage requirements such as are met with in this harbor warrant the construction of open piers wider than 80 ft. with two tracks on each side."

CONCLUSIONS.

As noted above, the fourth annual report, submitted in March, 1903, was referred back to the Committee for revision of the conclusions as to piers. We therefore submit revised conclusions below, but in doing so would call particular attention to the preceding remarks, and also to Section 1 ("Piers") of the conclusions:

(1) PIERS.—At rail-and-water terminals, the piers should be designed with a view to the most efficient, rapid and economical handling of the business, and with a view also to the future development of this business. Care must be taken to give due weight to the special conditions and features of location, traffic, etc., which exist in every case, and which render it impossible to lay down any but the most general rules for such piers. In every individual case, the length, width, number of tracks, width of platforms, details of construction, and width of waterway between adjacent piers, must be adjusted to best meet conditions as to shape and area of site, as well as its relation to its approaches from both land and water, the character and volume of the business and manner in which it is to be handled.

(2) COVERED LIGHTERAGE PIER.—When conditions will permit, present practice will generally suggest a length of approximately 600 feet, with two depressed tracks. If the business to be handled over the pier is expected to move quickly the width should be no greater than is necessary to provide temporary storage and shelter for the goods during ordinary detentions while waiting for cars or lighters, preferably about 100 feet. If the movement is expected to be slow and it is necessary to provide storage while waiting for cars or vessels, or for assorting, classifying, inspecting or sale of goods, the width should be increased, but generally

not beyond a width of 125 to 160 feet. If the movement is not expected to have a special character, or a mixed business is to be provided for, a compromise width of 125 feet is suggested. The space between the shed and the outer edge of the pier should be not less than two feet, and the clear width of waterway between piers should be, if possible, not less than four times the width of the largest vessels to be handled.

(3) Open Lighterage Pier.—This should, if possible, have a length of about 600 feet, and the width, number of tracks and the appliances for handling traffic should be adjusted to the particular use to which the pier is to be applied. On long piers crossovers may be necessary.

For ordinary coarse freight in bulk, such as iron ore, stone, timber and similar products, the width should be from 50 to 80 feet, and there should be four tracks, with crossovers, to facilitate the handling of cars and avoid delay in transferring to or from vessels. If the business is light, or is principally heavy or costly products, such as cut stone, machinery, or miscellaneous freight not requiring shelter, a narrow pier of about 35 feet in width, with two tracks only, is suggested.

(4) Export and Storage Pier.—This should be designed with special reference to the character of the commodities to be handled, whether quick movement is expected or the goods are to be held some time in storage for the accumulation of full cargoes, or for inspection or classification. There should be two tracks in a depressed pit on the pier level, which, on long piers, should be properly connected by crossovers at convenient intervals to facilitate the movement of cars. On very wide piers additional tracks on the pier level are desirable under certain conditions. Where the water front is limited or very valuable, and the conditions, volume and character of business warrant, pier sheds of two or more stories, with platform or barrel elevators and bag or barrel chutes, are used. Under certain conditions additional tracks in the second story may prove more advantageous than elevators. The length should be sufficient to properly accommodate either one or two vessels on each side at the same time, or approximately 600 to 1,400 feet. The width must be determined by the space available and the business to be handled. If quick moving, a width of 125 to 150 feet is recommended. If slow moving, and large accumulations must be received and stored, the width may be extended, if space permits, to 300 or even 400 feet, but excessive width is not recommended on account of the consequent increase in cost of handling. The space between shed and face of pier should not be less than three nor more than six feet, and the clear waterway between piers should be, if possible, not less than four times the width of the largest vessels to be handled.

(5) Coal Pier.—This should be an open pier, and where coal is to be delivered to vessels through pockets and chutes, in the ordinary way, the pier should be high enough to allow coal from drop-bottom cars to be loaded by gravity into vessels or barges. It should have three or more tracks, the outside tracks for loaded cars and the inside one on an incline to return the empty cars to the yard by gravity. The length depends upon the grade necessary to reach the desired

elevation, the length of the vessels to be coaled and the number of cars which it is desired to unload at one time. Adjacent piers should be sufficiently distant to accommodate the class of service, which will depend on the length of the pier and the size of the water craft to be accommodated. Where coal cars are dumped by machinery which elevates and tilts the cars, a high pier is not necessary, and it may be at any convenient height.

*(6) Station Pier and Team Track Delivery.—A city station pier served by car floats should be approximately 600 feet long and 125 feet wide, with a 35-foot depressed driveway in the center. It should be a closed pier, with three-foot platform outside. Adjacent parallel piers should be, if possible, 200 feet apart in the clear. Along the water street should be a bulkhead, approximately 50 feet wide, with two-story building, the upper floor being for offices, fruit auction room, etc.

(7) Grain Elevators.—These should be so located that cars can be run into them and loaded or unloaded, the tracks being so located that cars will feed to and from the proper part of the cluster or general yard without interference with other movements. The tracks should be arranged to feed cars in at one end and out at the other. Where this cannot be done, the tracks should be arranged so as to allow shifts of cars to be made without stopping all work.

Respectfully submitted.

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E. E. R. Tratman, *Vice-Chairman;* Resident Editor, Engineering News, Chicago, Ill.
J. A. Atwood, Chief Engineer, Pittsburg & Lake Erie R. R., Pittsburg, Pa.
M. S. Blaiklock, Superintendent, Grand Trunk Ry., Montreal, Canada.
E. P. Dawley, Asst. Chief Eng., N. Y., N. H. & H. R. R., Boston, Mass.
C. F. W. Felt, Chief Engineer, G., C. & S. F. Ry., Galveston, Texas.
F. O. Melcher, Superintendent, Ill. Div., C., R. I. & P. Ry., Chicago, Ill.
G. F. Morse, Assistant Engineer, Muskogee Union Ry., Muskogee, I. T.
C. S. Sims, General Manager, Baltimore & Ohio Railroad, Baltimore, Md.
F. S. Stevens, Superintendent, Philadelphia & Reading Ry., Reading, Pa.

Committee.

AMENDMENTS.

*(6) Station Pier.—A city station pier served by car floats should be approximately 600 feet long and 125 feet wide, with a 35-foot depressed driveway in the center. It should be a closed pier, with three-foot platform outside. Adjacent parallel piers should be, if possible, 200 feet apart in the clear. Along the water street should be a bulkhead, approximately 50 feet wide, with two-story building, the upper floor being for offices, fruit auction room, etc.

APPENDIX A.

PIERS AT OCEAN TERMINALS.

Boston & Albany Railroad (Boston, Mass.).—The Boston & Albany Railroad has a water terminal at East Boston, where the piers have been remodeled and two new piers built. On account of the course of the stream the piers had to be built to suit physical conditions. One of the new piers is a covered pier, 645 feet long on the west side, 780 feet long on the east side, and 240 feet wide, with two tracks. The other new pier is 780 feet long on the west side, 350 feet long on the east side, and 140 feet wide, with three tracks. The old piers are shorter. The piers are for ocean and coastwise steamers, and are used by some of the largest steamers of the Cunard line and Leyland line. As to clearance between docks, Mr. J. B. Stewart, superintendent, states that in his opinion 180 to 200 feet is a good clearance, but it depends very much upon the class of steamers to be accommodated and whether it is desired to have two steamers in one slip.

Bush Terminal Company (Brooklyn, N. Y.).—This great terminal plant has been designed by the company's chief engineer, Mr. E. P. Goodrich, and the company has done its own construction, under the direct supervision of its engineering force. There are seven piers, 1,300 feet long; one is 100 feet wide, one is 250 feet wide and the others are 150 feet. These are all served by tracks, as shown by the plan, Fig. 35, these tracks running to a large yard behind the company's warehouses. The slips between the piers are 270 feet wide, with 30 feet of water, but the pier construction is such as to allow of future dredging to a depth of 40 feet, if required. In regard to the width of pier, it is stated that cargoes from vessels of ordinary size can be readily stored in a space equal to the length of the vessel on a pier 150 feet wide. Behind the piers are the warehouses, 150x300 feet, six stories high, of slow-burning mill construction, with outside elevators and stairways. Thus the floors are unbroken and there are no shafts to carry fire from floor to floor. Freight is handled by one-ton and three-ton electric elevators, the latter being large enough to take a wagon and team. At the rear are loading platforms and a loading track. For inflammable goods, on which high insurance is charged, there are one-story brick warehouses, with fire walls, hydrants, automatic alarms, etc. The tracks on the piers are level with the general surface, so as not to interfere with trucking to any part of the pier. This is done for the reason that much of the freight goes out by horse trucks and lighter. If it was all loaded into cars, depressed tracks might be used, bringing the car floors level with the trucking platforms. Numerous cranes and hoists are provided. The freight yard extends nearly the whole length of the property and has a capacity for 1,000 cars. The tracks are level, but are

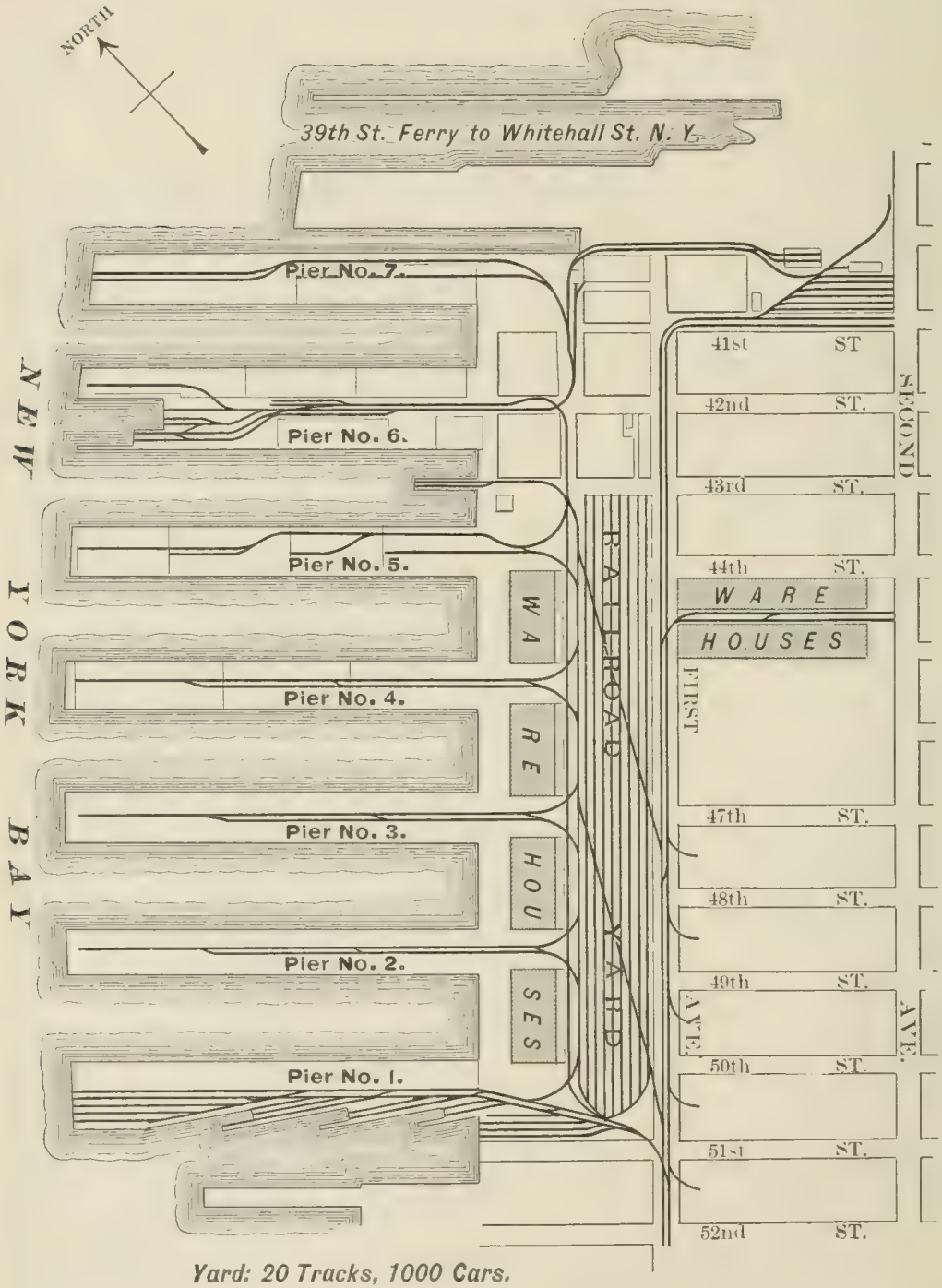


FIG. 35.—BUSH TERMINAL, BROOKLYN, N. Y.

crossed by two ladder tracks at a 2 per cent. grade, which allows for gravity switching into the several tracks of cars from a train backing down the ladder track. The handling of cars for these switching movements and for running cars on and off the floats is done by 50-ton switching engines. The tracks are laid with 75-pound rails in stone ballast, with No. 4 frogs and curves of 150 feet radius.

The piers, shown in cross-section in Fig. 36, are built on solid earth banks, retained by sheet piling, against which is laid rip-rap stone. The bank is not the full width of the pier, the floor of which extends and is supported by piling. Steel columns support steel roof trusses, with 1-inch plank sheathing and a composition tar and gravel roofing. There are ventilators and skylights, the latter aggregating nearly 10 per cent. of the roof area. The sides have an inward slope or better, and the side covering is composed entirely of doors. Both of these features of pier construction were regarded unfavorably in the Committee's report of 1902. Each door is divided horizontally. The lower section slides up behind the upper section and both can be then swung inward. In this way the openings may be reduced in bad weather.

New York, New Haven & Hartford Railroad (New York, N. Y.).—This company does not operate track docks in the city. Its work is largely the interchange of cars by floats and steamers between the Harlem River yard and Jersey City. The freight piers on the East River water front are of old style, varying very much in size, and not considered in any sense up to date. In addition to these there are what are called receiving sheds along the water front and between the piers, where the floats are tied up (head on) and unloaded upon the pier or loaded from the pier with outbound freight. The floats hold 10 or 12 cars each, and have an umbrella shed in the center, covering a platform along which the freight is trucked to and from the cars. About 20 floats are operated in connection with the East River pier service. Some notes of the history of the company's freight transfer system at New York are given in Appendix C.

New York Central & Hudson River Railroad (New York, N. Y.).—Mr. W. J. Wilgus, Fifth Vice-President (and formerly Chief Engineer), has furnished particulars of the principal terminals in New York harbor, and these are shown in Figs. 37, 38 and 39. The 60th St. and 30th St. terminals were constructed a number of years ago, and the design was controlled largely by local conditions. For these reasons they are perhaps not of special interest other than to direct attention to the increased size of more modern structures in this harbor.

The covered piers contain one-story and two-story sheds, from 60 to 90 ft. wide and about 450 ft. long at present, with a variety of track arrangements, as shown, which serve their purpose for piers of this size. These covered piers are used principally for east-bound package freight (including export or storage freight), and would be more efficient if they were both wider and longer. In connection with the track arrangement, it should be noted that two tracks reduce the unavoidable delays due to switching, for the reason that the stevedores can work

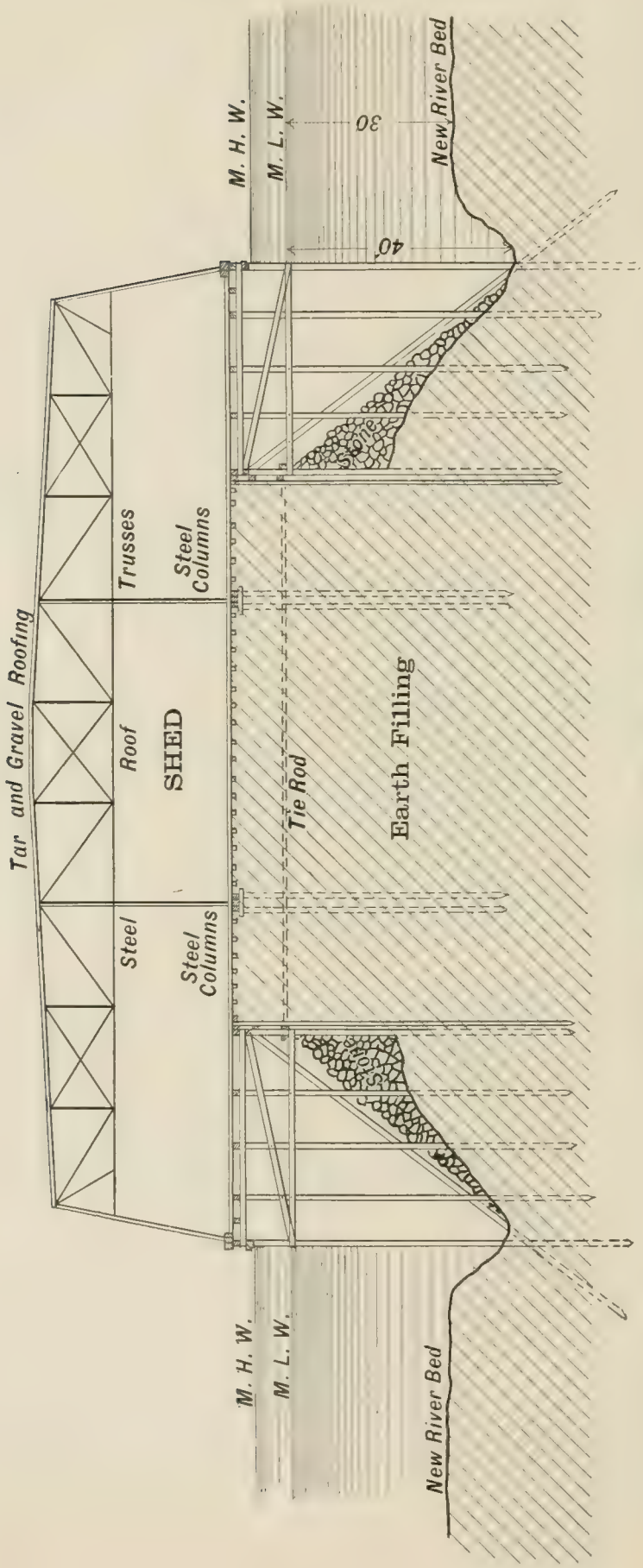


FIG. 36.—SECTION OF PIER, BROOKLYN, N. Y.

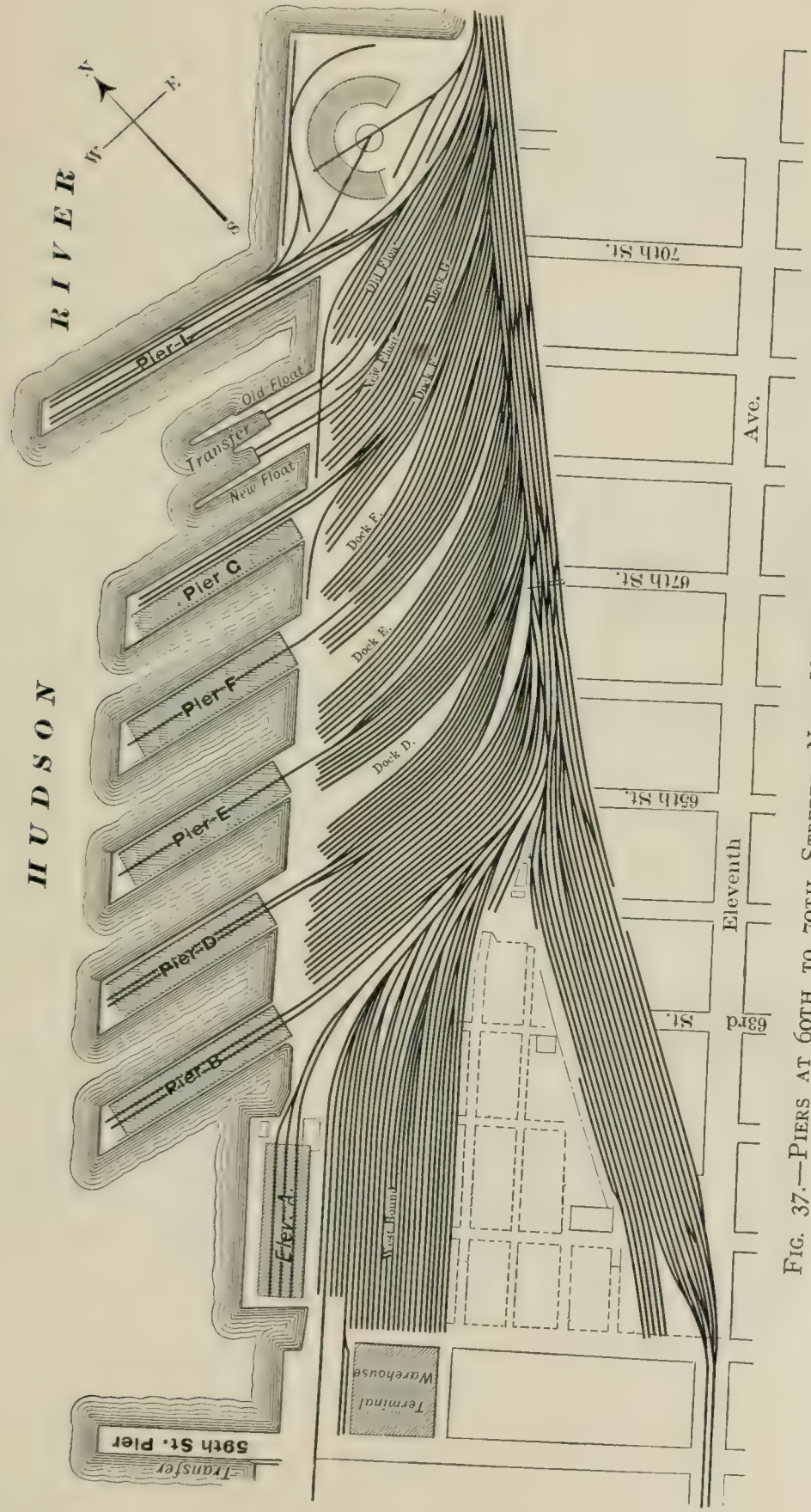


FIG. 37.—PIERS AT 60TH TO 70TH STREETS, NEW YORK; NEW YORK CENTRAL R. R.

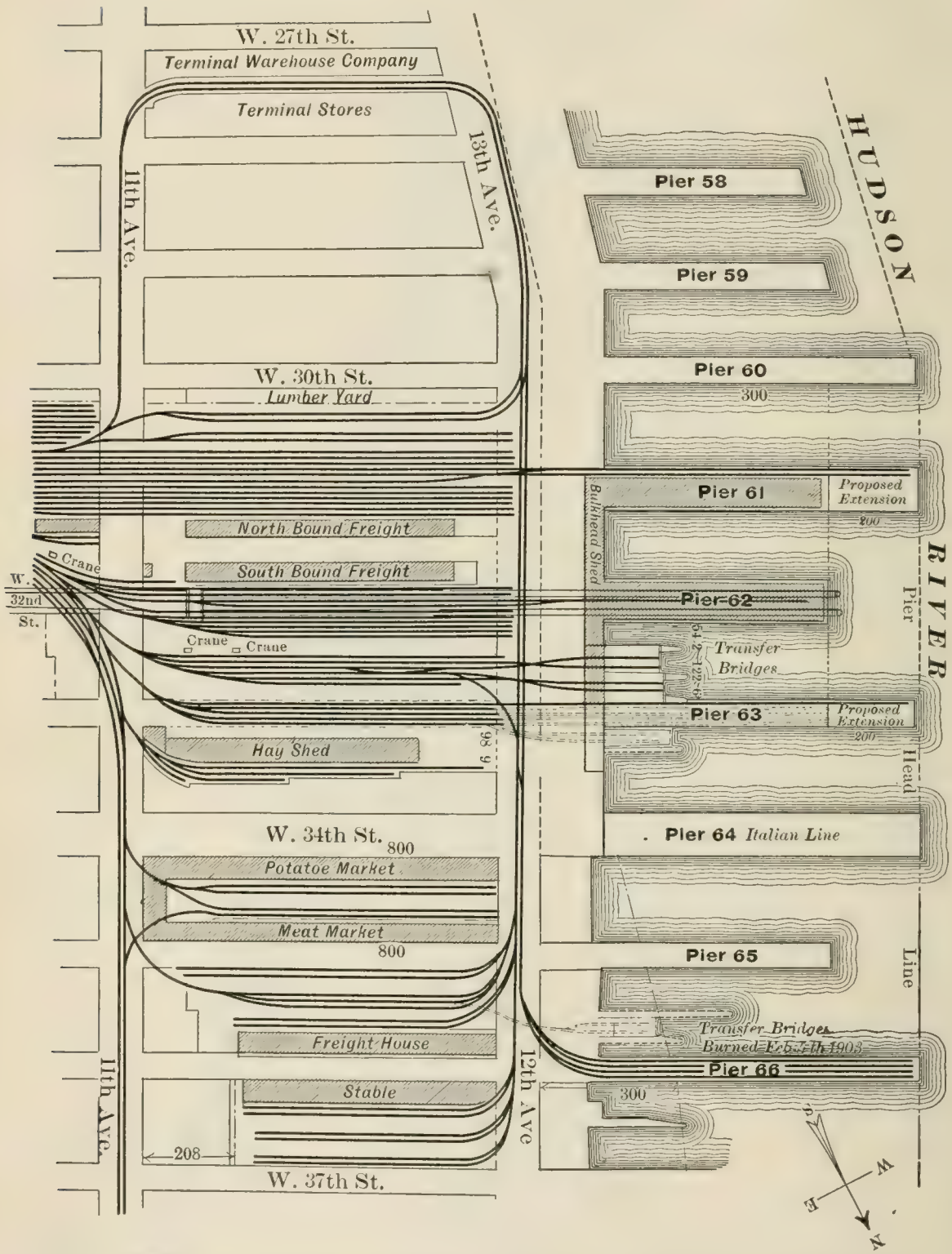


FIG. 38.—PIERS AT 30TH TO 37TH STREETS, NEW YORK; NEW YORK CENTRAL R. R.

FIG. 39.

Am. Ry. Eng. & M. W. Assn.

Committee on Yards and Terminals.

Convention of 1904.

PIERS AT WEEHAWKEN, N. Y.,

N. Y. C. & H. R. R. R.

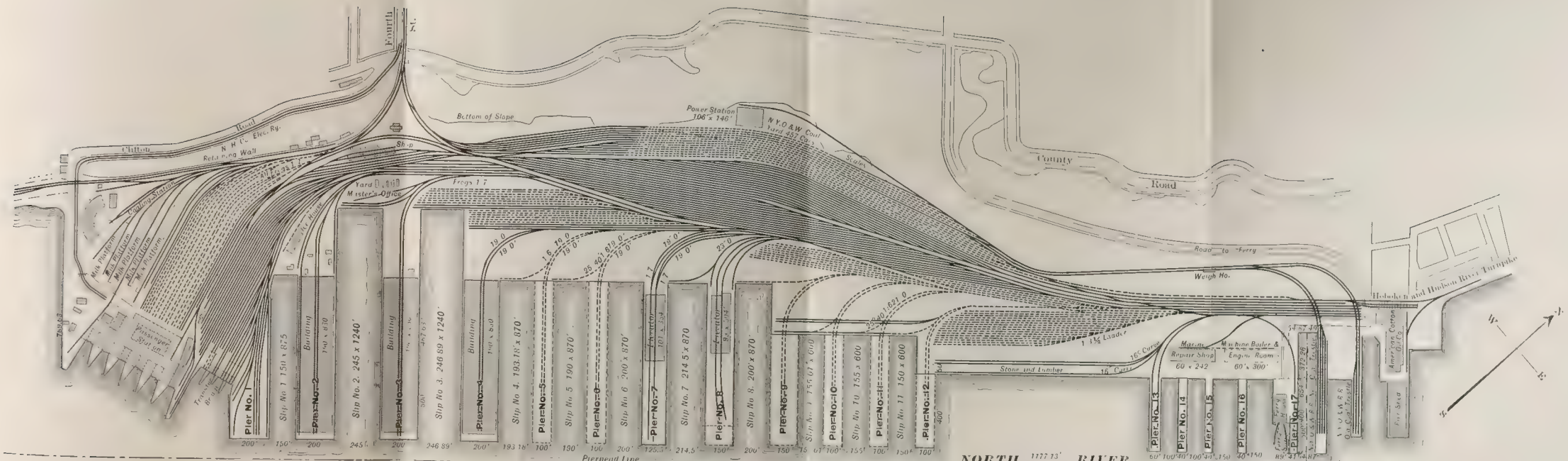


FIG. 39.—PIERS AT WEEHAWKEN, N. J., NEW YORK CENTRAL R. R.

on one string of cars while the other string is being shifted; also that the outside track along the stringpiece and the tracks along the bulkheads are very useful where open track space is restricted for direct delivery between cars and boats. The open piers, "I" (60x700 ft.), and No. 66 (55x700 ft.), each with four tracks, are very good as to length, width and number of tracks.

The Weehawken terminal, Fig. 39, is of much more recent construction and meets the requirements of the modern floating equipment and rolling stock. The covered piers, Nos. 2, 3 and 4, have two-story sheds, 830x90 ft., and are designed for east-bound storage (export) piers. Each has two tracks, with the exception of pier No. 2, which has a third track inside the shed; this was added at a time when direct delivery trackage space was restricted at this terminal. Open piers Nos. 1, 13, 15 and 17 are each designed to suit different conditions. Pier No. 1 is used in connection with the float bridge operations and for coarse freight shipments. Pier No. 13 for handling company lumber and ties. Pier No. 15 for marine shops, and pier No. 17 utilizes frontage that would otherwise not be available owing to the ferry slip.

The bulkhead space is utilized for open lighterage freight, for which it is equally as well suited as are open piers.

It is doubtful whether ordinary storage requirements, such as are met with in this harbor, warrant the construction of open piers wider than 80 ft., with two tracks on each side. The dotted piers and tracks indicate the future construction to suit the growth of business, but the dimensions are subject to changes to meet requirements as they arise.

Mr. D. B. McCoy furnishes the following table (Table No. 3) of the company's piers at the port of New York:

NOTE.—At New York, piers longer than 800 feet in the Hudson River are desired by the transatlantic steamer lines, and the city recently applied to the War Department for permission to extend piers 200 feet beyond the present established pier head line, which permission had previously been refused. The city is building a number of new piers and desires to make them 1,170 feet long without going further inland. Gen. Gillespie was detailed to investigate the matter, and reported against the pier extension. The channel of the Hudson River is now less than 3,000 feet wide, and with a reduction of 200 feet on both the New York and New Jersey sides (both applied for), the width would be only 2,400 feet. Besides the ocean steamer traffic there is a large up-river traffic and a cross-river traffic of both passengers and freight, in addition to which is the harbor service of tugs, etc. In view of this traffic and of the difficulty of navigating all this traffic in bad weather, the application was denied.

Lehigh Valley Railroad (Jersey City, N. J.).—In Fig. 40 is given a plan of the Jersey City terminal piers. All of these are used for lighterage, and the open piers, "A" and "D," are also used in addition for steamer freight in bulk, such as ore, sulphur, etc. The piers are diagonal to the shore line, and their dimensions are given in Table No. 4:

TABLE III.

Piers of New York Central & Hudson River Railroad in New York Harbor.

Location	Pier No.	Size of Pier. Feet.	No. or Location of Slip.	Size of Slip. Feet.	Traffic.	No. of Tracks on Pier
Weehawken Terminal, N.J.	1	875x200	1	875x150	Lighters	7
	2	1240x200	2	1240x245	Steamer	3
	3	1240x200	3	1240x245	Lighters	2
	4	1240x200	4	870x190	"	2
	7	870x125	7	870x214½	"	2
	8	870x150	8	870x200	"	2
	13	400x 60	13	400x100	"	2
	17	654x 41	17	654x 50	"	.....
South St.	New 4	564x 70¼	So. of Pier No. of Pier	600x190 563.3x190	Lighters	.....
East River.	New 34	425x 80.1	So. of Pier No. of Pier	425x170 470x175	Lighters	.....
North River.	16	707.5x 44.3	Between Piers	710x180	Lighters	.....
	17	709.9x 54.7			"	.....
	23	675.8x 70.1	.....	.....	"	.....
	31	845 x 60	.....	.....	"	.....
	61	501 x100.5	Bet. 61 & 62	500x157	"	2
	62	499.5x100	Bet. 62 & 63	500x173	"	1
	63	499.5x 60	.....	.....	"	5
	66	535 x 50	.....	.....	"	2
	89	700 x 60	.....	.....	"	.....
	B	471 x100	.....	.....	"	2
	D	502 x100	B to D	480x150	"	2
	E	500 x100	D to E	560x150	"	1
	F	492 x100	E to F	495x140	"	1
	G	500 x100	F to G	498x155	"	2
	I	719 x 60	.....	.....	Steamer	4
Port Morris.	.....	210 x 44	Between Piers	244x100	Lighters	2
	.....	244 x 44			"	3

TABLE IV.

Piers of Lehigh Valley Railroad at Jersey City.

	Pier	Width of Slip.	Tracks.	Width of Warehouse.
Pier A	100 ft. wide.	100 ft.	3	(Open)
Pier B	100x600	100	2	85
Pier C	100x600	100	3	85
Pier D	100x600	100	3	(Open)
Pier G*	120x560	100	1	112*
Pier H	120x580	100	1	112
Pier I	142x580	.....	3	130

All tracks depressed; base of rail 4 feet below floor of pier.

Inclines, gangways or ramps at intervals.

*Proposed new pier, 142x580 feet, with three-story warehouse, 127 feet wide. Two tracks in middle of warehouse, one outside, all with base of rail 4 feet below floor of pier; 13-ft. platform outside on one side; no platform on the other side.

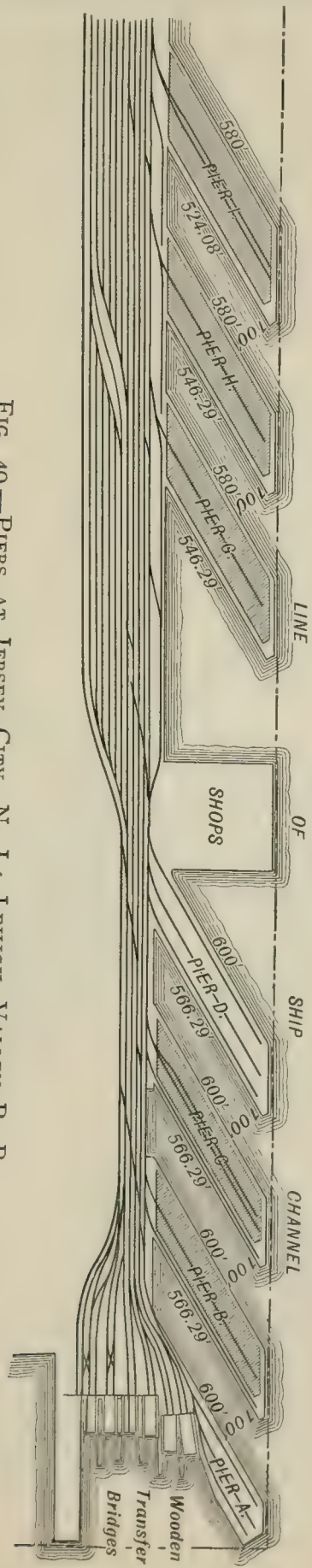


FIG. 40.—PIERS AT JERSEY CITY, N. J.; LEHIGH VALLEY R. R.

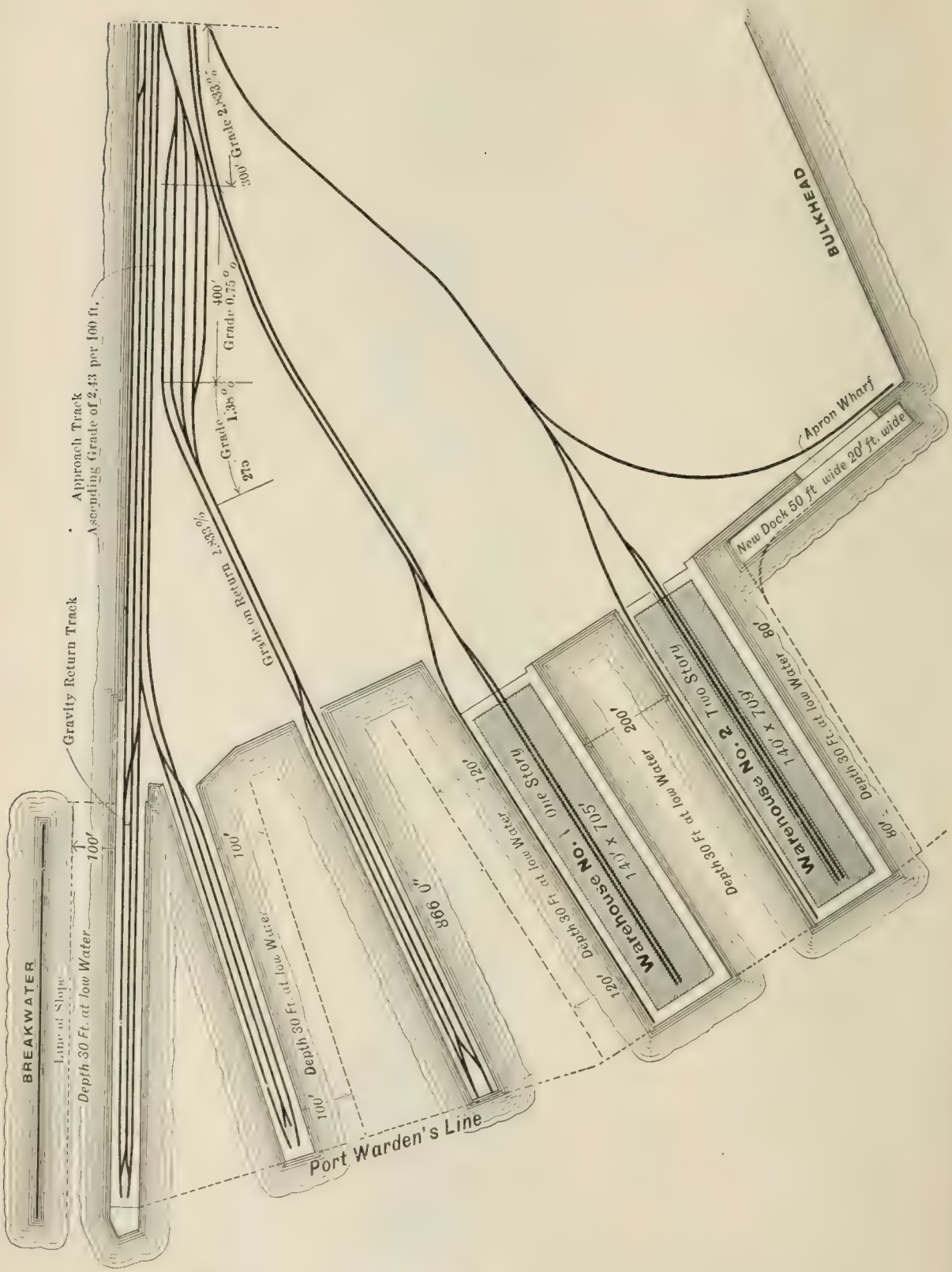


FIG. 41—TERMINAL OF NORFOLK & WESTERN RAILWAY AT LAMBERT'S POINT, NORFOLK, VA.

Norfolk & Western Railway (Norfolk, Va.).—In Fig. 41 is a plan of the Lambert's Point terminal, with piers and warehouses. Piers 1 and 2 are used for ocean steamers, which come up direct to the pier and are loaded by means of skids in conjunction with the steamers' hoisting engine. One of these warehouses is a two-story structure. A good deal of material has been shipped in the past from this second story, but it has not been found at all necessary, and the bulk of the business is still handled from the first story. The class of freight handled covers almost everything—flour, produce, cotton, lumber, timber, pig iron, etc. There is also, of course, a lighterage business from these warehouses to other warehouses in exchanging freight, but ocean steamers are loaded directly at both of these piers.

Southern Railway (Norfolk, Va.).—The plan of the terminal property at Pinner's Point is shown in Fig. 42 and it is explained that, like many others, it has been made largely to conform to local conditions. It represents present facilities and not an ideal arrangement. Mr. D. W. Lum, Engineer of Bridges and Buildings, has furnished the following statement from Mr. E. T. Lamb, General Agent at Norfolk:

"Our Piers 1 and 2 are used almost exclusively for coastwise vessels, while Pier 4 is used for ocean vessels, and the majority of freight going out of these piers goes direct to vessels. The character of freight handled is cotton, lumber, pig iron, merchandise, cotton factory products, tobacco, fertilizer.

"Where a large business is handled, such as is done by our company, and room is necessary to accommodate accumulation to provide full cargo for vessels, as we do, I do not think it is possible to work successfully with any narrower pier than we have. On two of our piers, namely, 2 and 4, we have a track on the outside of the warehouse, upon which we place all carload freight, handled direct from cars to vessels. The difference in trucking freight after it once gets on a truck as between 100 and 150 feet is so small it is almost impossible to figure it. I therefore consider that a pier for handling of miscellaneous business, such as our pier No. 1, 196 feet wide with three tracks running through the center, with about 11 feet centers, is about the most economical pier we could get, allowing 12 feet truckway on each side, leaving a distance between that and the ship of about 59 to 60 feet. While the conditions are somewhat different with respect to our Piers 4 and 2, the character of business handled on those piers, especially as to pier 4, is somewhat different, and much more room is required in order to accumulate full cargo to foreign steamers and release cars promptly. The increased cost of operating a pier of this kind for export business is a very small matter as compared with the revenue saved to the company in the prompt releasing of its cars."

Southern Railway (Charleston, S. C.).—There is at Charleston, on Pier No. 1, a warehouse, 80x350 ft., with one track running through the center; Pier No. 2 is 50x445 ft., with shed 44x420 ft., with two tracks on extreme north side; Pier No. 3 is 80x460 ft., with warehouse, 75x420 ft., one track in center; Pier No. 4 is 75x390 ft., open, with one track. The company has found that Pier No. 3 is economical in the matter of

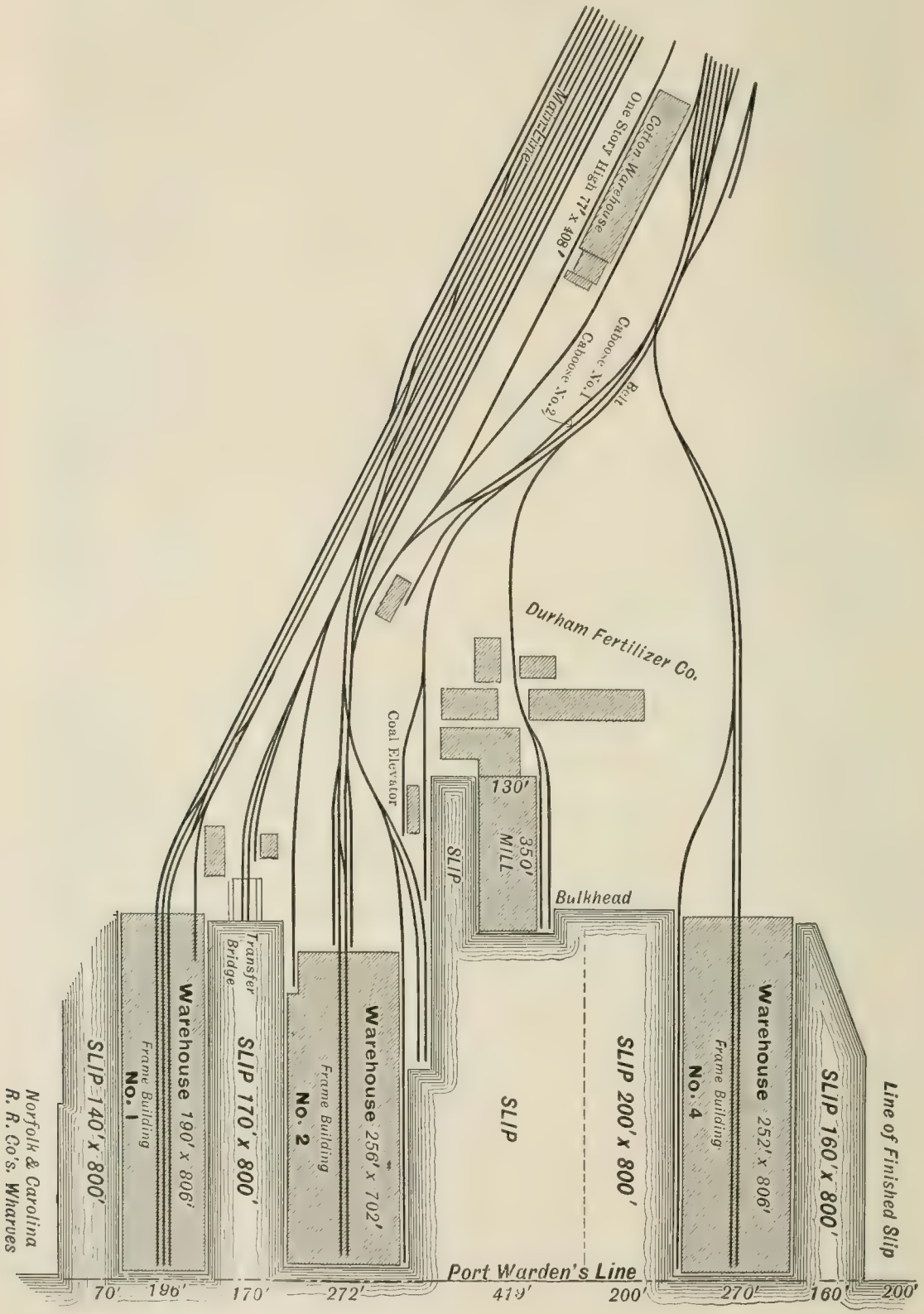


FIG. 42—TERMINAL OF SOUTHERN RAILWAY AT PINNER'S POINT, NORFOLK, VA.

handling business, for the reason that trucking is not for any distance, and that the ship side deliveries or storage capacity of the pier is equal to the amount of business that can be handled daily. The length is also suitable to the class of business handled at Charleston.

Pier No. 1 handles coastwise traffic, consisting of merchandise, machinery; in fact, all classes of freight. Pier No. 2 is occupied almost exclusively in importing fruit and exporting merchandise, domestics, etc., to and from the West Indies and South America. Piers No. 3 and No. 4 are devoted to export business for European and Continental points, and the principal traffic is cotton and cotton-seed meal, pig iron, etc. There is no lighterage traffic, all traffic being handled either by railway or by steamer. The steamers lie on each side of the piers. For width of water space there is about 100 feet maximum and 45 feet minimum, but in order to accommodate the shippers this space should not be less than 100 feet between the wharves. Mr. J. H. Heether is superintendent.

Louisville & Nashville Railroad (Pensacola, Fla.).—The principal features of the water terminal at this cotton shipping port are two long piers, separated by a slip 100 ft. wide between fenders. The Commandancia Street pier is used for ocean vessels. It is 1,227x108 ft., with a warehouse 1,202x108, leaving 25 ft. of open pier at the end. There are two tracks on one side and one at the other, all depressed, with the rail head 4 ft. below the floor. The warehouse is two stories high, and has the same arrangement of tracks on the upper floor. On this floor the sides are set in, so as to form a 15-ft. gallery along each side. The clear height is 16 ft. on the first floor and 12 ft. 9 in. on the second.

The Tarragona Street pier is about the same length, but 142 ft. wide. Near its outer end is a building, 50x814 ft., with its floor 4 ft. above the deck of the pier, which is 10 ft. above the water. Ramps or inclines let into the floor extend to the deck level. On one side of the building the deck is 64 feet wide, with five tracks. On the other side it is 26 ft. wide, with two tracks. The building is divided to form an export warehouse, 50x410 ft., and a storage warehouse, 50x404 ft., the latter being at the outer end and divided into 11 rooms, 36x48 ft. On the northern side of the deck the track next to the export warehouse is 14 ft. above the deck of the pier, and on the outer side are gangways or chutes (suspended from the overhanging edge of the roof) to the vessels. Freight can be delivered direct to vessels by these chutes, or into the building through doors. At the end of this track is a bumper. Beyond it, a second track leads from the track along the edge of the wharf and runs alongside the storage warehouse on the deck level.

There is also a combination coal and freight pier 500x120 ft., at the sea end of a long three-track trestle approach. The upper deck is along one side of the pier, and has two tracks. The lower deck has five tracks, two under the upper deck or coal trestle, one close alongside the trestle, and two on the opposite side of the pier. There was originally a storage warehouse along the middle of the pier, between the three and two tracks. The loaded cars for the upper deck are taken up an incline of 4 per cent., and the delivery track has a down grade of 3 ins. per 100 ft. to the sea

end of the pier. It terminates at a pivoted turntable or transfer table (pivoted at its outer end), by which the empty car is transferred to the return track. This track has a down grade of 3 ins. per 100 ft. to the shore end of the pier, and then descends on a grade of 4 per cent. to the approach. Coal from hopper cars and grain from box cars is delivered directly to the vessels through the chutes and spouts (along one side of the deck). At the same time, freight can be handled between the vessels and cars standing on the tracks on the lower deck of pier. The coal chutes and grain spouts are hinged and have extension aprons, so as to accommodate the position of hatches of vessels of any size, empty or loaded, at any stage of the tide.

Mobile & Ohio Railroad (Mobile, Ala.).—From Mr. H. W. Clarke, Superintendent of Transportation, we have a statement and plan, Fig. 43, regarding the Mobile water terminal, but he points out that it was necessary to plan the piers, warehouses, etc., to conform with existing conditions and with length and width of property, etc. The accompanying plan shows Piers Nos. 1, 2, 3 and 4. Piers Nos. 1 and 2 form a joint warehouse pier, 137x200 ft. by 500 ft. long, with a one-story warehouse 70 and 140 ft. by 600 ft. long built upon it, the floor of this warehouse being on a level with the car floors. On the south side of the warehouse is constructed a trucking platform extending out 6½ feet wide from side of building. This is used for trucking freight in and out of the warehouse. As shown by the plan, one track parallels this platform and is used for inbound and outbound business. On the north side of warehouse the platform is eliminated, freight being handled from side hatches of steamers and trucked up inclines built into wharf and extending into warehouse. As will be seen by the plan, there is also one track on the north side of this warehouse, which is used for outbound and inbound business.

Pier No. 3 is an open pier, 500x60 ft., with two tracks upon it. The conveyor from elevator being on this pier precludes the use of another track. Export timber is handled from this pier.

Pier No. 4 is also a warehouse pier, 500x150 ft. The warehouse is two stories high, with two tracks on either side, as shown. It is 90x600 ft., with a 30-ft. platform and two tracks on each side. The import and export business is handled exclusively through this warehouse, and the floor is on a level with top of rail, freight being handled over gangways from warehouse to steamer, or vice versa.

With this arrangement of water terminals, vessels can discharge or take on their cargoes at either the side or end of warehouses or piers.

On Piers Nos. 2, 3 and 4 the arrangement of tracks had to conform to existing conditions, as the business handled through these warehouses is strictly inbound and outbound, or what might be termed combination warehouses. Otherwise the arrangement of tracks would be somewhat different.

The slip on the south side of Pier No. 1 is 100 ft. wide and 300 ft. deep. That between Piers Nos. 2 and 3 is 100x450 ft.; and that between Piers Nos. 3 and 4 is 90x450 ft. The length and width of slips between

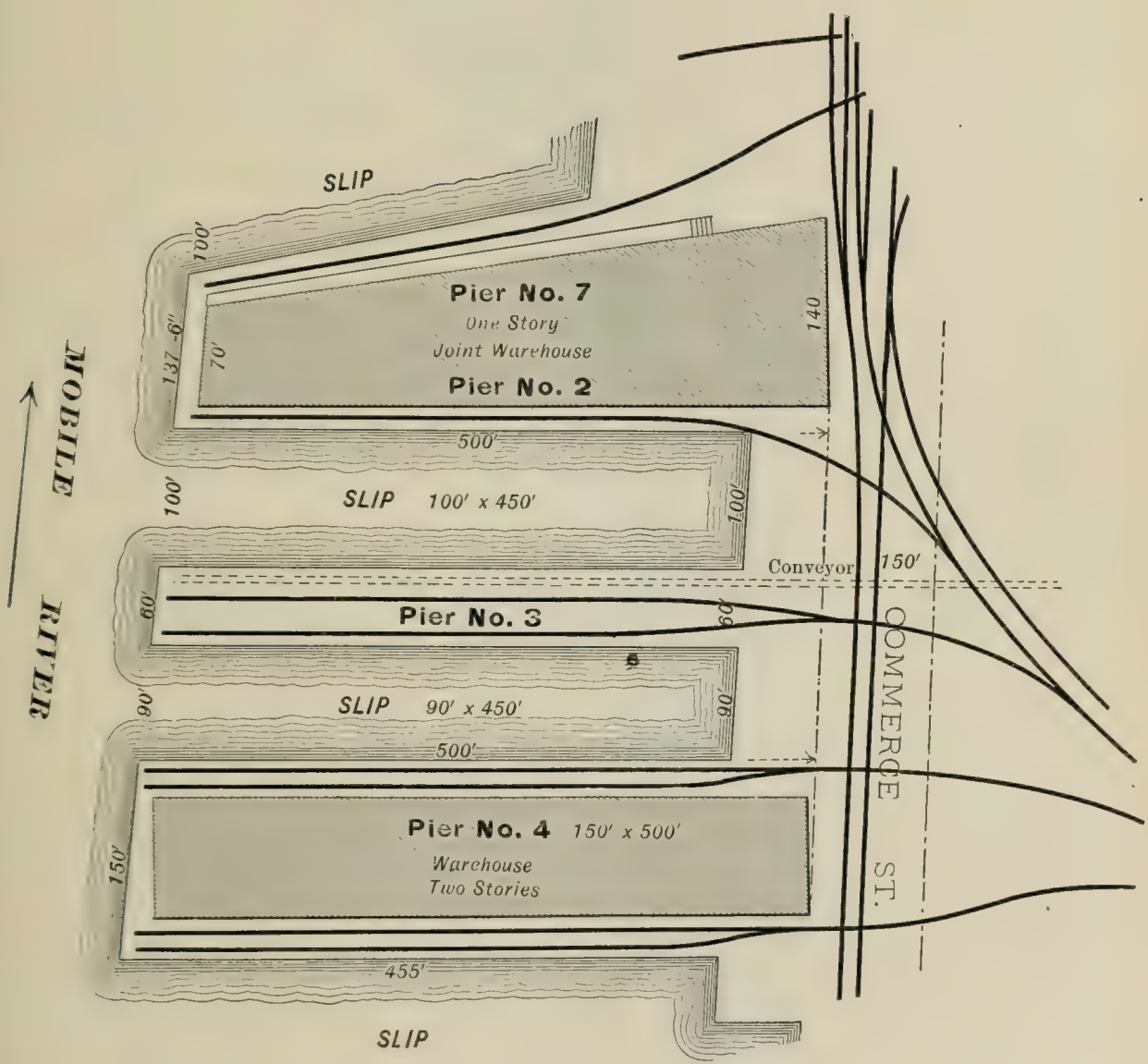


FIG. 43.—PIERS AT MOBILE, ALA.

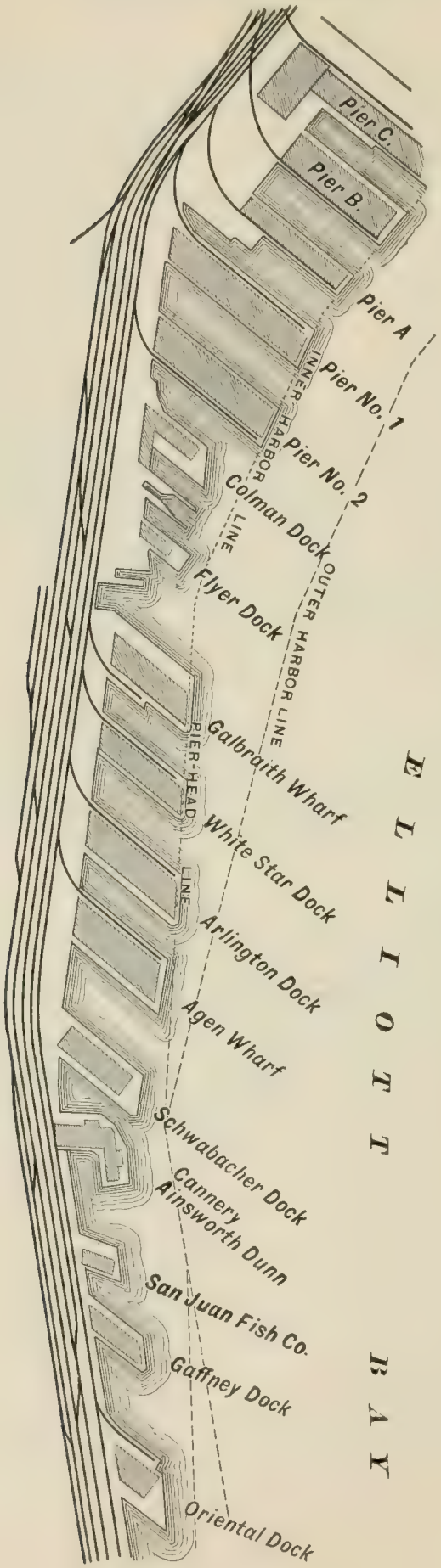


FIG. 44.—PIERS AT SEATTLE, WASH.

piers will accommodate any length of steamer that comes into this port, but could be made longer if the demands required it.

Northern Pacific Railway (Seattle, Wash.).—Fig. 44 is a plan of the piers and warehouses at this ocean port. The piers extend to the inner harbor line (300 ft. from the outer harbor line), and are diagonal to the shore line. The dimensions are given in Table No. 5.

TABLE V.

Northern Pacific Railway Piers at Seattle, Wash.

	Slip.	Pier.	Warehouse.	Side Platform.
Pier C		385x100	430x 80	10 ft.
Slip	400x 90			
Pier B		400x130	385x100	15
Slip	400x119			
Pier A		400x 80	386x 60	13 and 7
Slip	125x532			
Pier 1		625x125	610x100	5 and 20
Slip	495x124.3			
Pier 2		520x130	500x100	5 and 25
Slip	395x100			
Colman Pier		250 & 200x110	124x 45	18 and 47
Ferry Slip				
Flyer Pier		180 & 112x 75	100x 40	20 and 15
Slip	150 ft. wide.			
Galbraith Pier		310x148	300x 80	52 and 16
Slip	102.7 ft. wide.			
White Star Pier		325x112	309x 80	16
Slip	110.7 ft. wide.			
Arlington Pier		350x145	2 story 332x100	20 and 25
Slip	85 ft.			
Agen Pier		350x138	334x100	20 and 18
Schwabacher Pier		325x122	240x 81	20½ and 21½
Gaffney Pier		208x 75	197x 55	17 and 13
Oriental Pier		196x173	187 & 96x80	

The Arlington Pier has a warehouse 100 ft. wide, with a space of 20 ft. on one side and 25 ft. on the other, the pier being 145 ft. wide. The 25-ft. space has a single track along it. The warehouse is two stories high. It is divided into three bays by two rows of posts, the middle bay being 33 ft. and the side bays 33 ft. 6 ins. center to center of posts. The posts of the lower story are 12x14 ins. for the walls and 16x16 in. for the interior, all 20 ft. apart lengthwise of the building. Corbels 6 ft. long carry girders 14x20 ins. in the walls and 16x27 ins. inside. On these are other corbels, with braces to the post. Upon the caps are floor joists, 4x18 ins., 16 ins. center to center. The clear headway of the lower floor is 15 ft. 6 ins. The upper story has a clear height of 25 ft. 4 ins. in the center bay, with a roof sloping 4 ins. to the foot from the ridge. The side bays are 18 ft. 6 ins. high at the inner side and 7 ft. at the walls. Windows are fitted in the vertical walls of the middle bay, above the roofs of the side bays. The lower floor has sliding doors, suspended from rollers on an overhead rail. There is a doorway 8x10 ft. in every panel of the sides, and the doors are 8 ft. 2 ins. wide by 13 ft. 10 ins. high.

APPENDIX B.

RAILWAY TERMINAL FACILITIES FOR ORE AND COAL TRAFFIC ON LAKE ERIE.

(From the "Blue Book of American Shipping," 1903.)

In the following paragraphs brief summaries are made of the machinery equipment on some 38 docks at Lake Erie ports, over which 22,649,424 gross tons of ore and about 15,000,000 tons of coal (anthracite and bituminous) were handled during the navigation season in 1902. At most of these docks vessels of 3,000 to 5,000 gross tons' capacity can be unloaded in a single working day. Some of them have records of 6,000 to 7,000 gross tons unloaded from ships of 450 to 500 ft. length in seven to twelve hours. Ships are often held as much as three days awaiting turns at the dock.

BUFFALO, N. Y.

Buffalo Union Furnace Co.—Dock A: Four McMyler cantilever machines, which are movable and will work hatches of 16-ft. centers and over; capacity, about 125 tons per hour. Dock B: Brown hoists, four rigs of about 150 tons' capacity per hour, and two McMyler whirlies. Dock B is equipped with Hulett clamshell buckets and Andrews scrapers.

Delaware, Lackawanna & Western Railroad.—Docks in Erie basin: Six-rig Excelsior hoist, capable of unloading 2,000 gross tons in 10 hours. All rigs can be worked on vessels having hatches of 24-ft. centers or less. No storage room.

Rochester & Pittsburg Coal & Iron Co.—Hulett car dumper for loading coal; capacity, 500 tons per hour; fuel lighter of 600 tons' capacity.

Buffalo, Rochester & Pittsburg Railway.—One automatic Hulett ore unloader; one Brown hoist of two legs, equipped with Hulett automatic buckets; two revolving derricks. No storage for ore.

Minnesota Dock Co.—Five McMyler revolving derricks on dock and two of same type on lighters. The latter are for steamboat fueling business, and are available for handling ore when required.

Lehigh Valley Railroad.—Two Brown hoists, with three legs each, and one 40-ton derrick.

West Shore Dock.—Five McMyler rotary derricks, equipped with Hulett clamshell buckets.

Tonawanda Iron & Steel Co.—Brown hoisting and conveying plant of four legs.

CONNEAUT, O.

Pittsburg & Conneaut Dock Co.—Five Brown rigs of three legs each and one of two legs; three King rigs of two legs each; 20 revolving derricks or whirlies. Also four McMyler direct ore unloaders of three legs each and ricks. Also four McMyler direct ore unloaders of three legs each and four Hulett automatic direct ore unloaders, which latter are of the largest and fastest kind. A McMyler car-dumping machine for transfer of coal

and coke, and a special device for handling steel rails, are also in service on these piers, as well as seven steam shovels for loading from docks to cars.

ERIE, PA.

Erie & Pittsburg Railway.—There are 24 Brown hoists of 1896 design, 12 of which are equipped with Hulett automatic buckets and Andrews scrapers.

Philadelphia & Erie Railway.—Six McMyler revolving derricks of 1890 design, capable of unloading 3,000 tons per day of 12 hours. Also portable revolving derrick for loading ore from dock to cars.

ASHTABULA, O.

Pittsburg, Youngstown & Ashtabula Railway (Pennsylvania Lines.). —Three plants, two of which have 12 legs, and one of which has 8 legs. The latter is equipped with Hulett clamshell buckets. One of the 12-leg plants is also equipped with these buckets, and in addition has Andrews scapers. Two of these plants may be divided, so as to work any number of hatches. The third is stationary, suited to work any number of hatches up to twelve. At this third plant, hatches of any distance between centers, from 24 ft. upward, may be worked. There are also on this dock five revolving derricks that may be worked any way in which they are fitted to vessels. Two fast conveyor plants for transfer of coal at this point are constructed on principles entirely different from the McMyler and Brown car dumps, but are of about equal capacity.

Lake Shore & Michigan Southern Railway.—Pier No. 1 has 3 Hoover & Mason clamshell automatic unloaders and 10 Brown hoist machines. Pier No. 2 has 12 Brown hoists. Pier No. 3 has 6 Brown hoists and 6 McMyler rotary machines. Pier No. 4 has 6 Brown hoists, 6 Variety conveying machines and 5 McMyler rotary machines. Pier No. 5 has 7 Hoover & Mason clamshell automatic unloaders. Pier No. 6 has 8 Brown hoists and 6 McMyler rotary machines. Pier No. 5½ has a McMyler car-dump machine for loading coal that has made a record of 1,600 tons in one hour. On the main river front are 4 Hoover & Mason automatic clamshell unloaders. In the total equipment of the L. S. & M. S. Ry. piers at Ashtabula are 79 ore-hoisting machines (of which 14 are Hoover & Mason clamshells), 3 McMyler coal-loading machines, and 5 steam shovels for loading ore from dock to car.

FAIRPORT, O.

Pennsylvania & Lake Erie Dock Co.—Six Brown rigs of three legs each. These rigs can be used together or separately. There are also on this dock 18 McMyler revolving derricks, which are used for unloading direct into cars. On the dock is a McMyler car dump and a fast conveyor plant for loading vessels from hopper cars.

CLEVELAND, O.

New York, Pennsylvania & Ohio Dock Co.—Eight Brown plants of three rigs each; all are portable and can be divided up in any way de-

sired. Three Hoover & Mason clamshell machines, with storage pockets of 3,000 tons' capacity.

Cleveland & Pittsburg Railway Ore Dock.—One plant of 12 legs, five plants of 3 legs each and four plants of 4 legs; all of the Brown type and all arranged so that they may be moved to suit any number of hatches. The 12-leg plant is equipped with Hulett clamshells and Andrews scrapers. There is also on this dock, erected in 1903, a Hoover & Mason 6-leg clamshell automatic unloading plant.

Wheeling & Lake Erie Railway.—Four McMyler rotary hoists of 1,200 tons daily capacity.

American Steel & Wire Co.—Two McMyler rotary machines with grab buckets; two McMyler conveyors with grab buckets; four McMyler conveyors with ordinary buckets; seven King Bridge Co. conveyors with ordinary buckets.

River Furnace.—Eight Noble & Hall dredge cranes. About four of these can be used to advantage on a vessel.

Pittsburg Coal Co.—On Valley dock, 5 McMyler rotary hoists, capable of unloading a vessel of medium size in 12 hours. At Seneca Street bridge is a McMyler car-dump machine for loading coal. In the main river, above Central viaduct, are two Excelsior Iron Works car-dump machines, and another car-dump machine is in the outer harbor within the east breakwater. Another pier, between Main Street bridge and the old river bed, in the main river, is equipped with pockets and a rotary hoist for fueling steamboats.

LORAIN, O.

Baltimore & Ohio Railroad.—For iron ore: Ten legs of Brown hoist type and 72 revolving derricks. For coal: An improved McMyler car-dumping machine; capacity, 5,000 tons in 10 hours. Also a 5-ton revolving derrick and pocket fueling scow of 500 tons' capacity, equipped with a 5-ton hoisting derrick.

Lorain Steel Co.—Twelve McMyler hoisting and conveying machines of the latest type, suited to taking ore from vessels of any size.

HURON, O.

Wheeling & Lake Erie Railway.—Ore hoisting and conveying plant of 4 legs, and 8 rotary derricks, all of McMyler manufacture. Car dump of McMyler type.

SANDUSKY, O.

Cleveland, Cincinnati, Chicago & St. Louis Railway.—No iron ore business. Five revolving derricks of Excelsior type used for loading coal.

Baltimore & Ohio Railroad.—One plant of six legs, called Beckert derrick; can be moved to suit hatches. Also fast plant for transfer of coal from cars to vessels.

Pennsylvania Company (Short Line).—Three McMyler rotary hoists handle coal and ore. Car-dump machine, built by Webster, Camp & Lane, for transfer of coal to vessels.

TOLEDO, O.

Toledo & Ohio Central Railway.—Four derricks of Excelsior and McMyler kind. Also car-dumping machine of Brown type for coal.

Cincinnati, Hamilton & Dayton Railway.—Five McMyler rotary hoists, capable of handling about 160 gross tons per hour. Also a McMyler machine of 600 tons' per hour capacity for transferring coal.

Hocking Valley Railway.—Four rotary derricks and two ore unloading machines, 4 legs, of Brown type. Two car dumps of Brown type for loading coal.

Toledo Furnace Co.—Two Hoover & Mason fast automatic machines.

DETROIT, MICH.

Detroit Iron & Steel Co.—On Zug Island, two Hulett automatic unloading machines, with Andrews scrapers, for four hatches.

COAL CAR DUMPING MACHINES.

Table No. 6 gives a list of car-dumping machines for the transfer of coal from railway cars to ships at Lake Erie ports. Vessels of as much as 7,000 tons' capacity are supplied, when the coal is all at hand, with full cargoes in a single day by the use of these machines in transferring from cars to ships. Of course, the vessels often wait two, three and four days for cargoes when coal is not at hand and when the docks are crowded.

TABLE VI.

Coal Car Dumping Machines at Lake Erie Ports.

Lake Port.	Pier	Builder of Machine.
Toledo	Hocking Valley Ry	Brown Hoisting Machine Co.
"	Ohio Central Ry.	" " " "
"	Cin., Ham. & Dayton Ry.	McMyler Mfg. Co.
"	Toledo & Ohio Central Ry.	Brown Hoisting Machine Co.
Sandusky	Columbus, Sand. & Hock. Ry.	Webster, Camp & Lane Co.
"	B. & O. R. R.	B. & O. R. R. engineers.
Huron.	Wheel. & L. E. Ry.	McMyler Mfg. Co.
Lorain	B. & O. R. R.	" " "
Cleveland	Cleve., Val. & Terminal Ry.	" " "
"	Erie Railroad	Excelsior Iron Works.*
"	Pennsylvania Co.	McMyler Mfg. Co.
"	" "	Excelsior Iron Works.*
"	" "	McMyler Mfg. Co.
Fairport	P. F. & N. Dock Co.	" " "
"	" " "	C. O. Bartlett & Co.†
Ashtabula	Pennsylvania Co.	" " " †
"	L. S. & M. S. Ry.	McMyler Mfg. Co.
"	Pickands, Mather & Co.	" " "
"	" " "	" " "
Conneaut	Pittsburg & Conn. Dock Co.	" " "
Erie	Pennsylvania Co.	" " "
Buffalo	Roch. & Pitts. Coal & I. Co.	Webster, Camp & Lane Co.

* The Committee finds that this company has now been absorbed by the McMyler Mfg. Co.

† The Committee finds that these are not car-dumping plants; hopper-bottom cars deliver coal into a conveyor, which discharges into the hold, as described in the report.

APPENDIX C.

THE PASSENGER AND FREIGHT TRANSFER SYSTEM AT HARLEM RIVER, NEW YORK.*

Up to November 24, 1873, all the New York passenger and freight business of the New York, New Haven & Hartford Railroad Company came over the New York division via 42d St.; the freight cars being drawn through the city by horses to and from Centre St., along 4th Ave., and the passenger cars from the station between 26th and 27th Sts., on 4th Ave (where the Madison Square Garden now stands), to 42d St., where they were made up into trains and hauled by locomotives.

During the year 1869, parties secured a charter from the New York legislature to build the Harlem River & Portchester Railroad, from New York to New Haven, which was a scheme to parallel the New Haven Railroad, but owing to the pecuniary embarrassment of that company, growing out of the financial troubles of the fall of 1869, an opportunity was furnished the New Haven Company to take the control and management of the road then in process of construction, which opportunity was embraced by it. There being a large population situated between New Rochelle Junction and Harlem river without railroad facilities, the directors of the New Haven Railroad, after careful consideration, became convinced that it was their duty to proceed with the construction of a first-class double track railroad over that part of the Harlem River & Portchester Railroad lying between Harlem river and New Rochelle (now known as the Harlem River branch) to connect with the New Haven road at New Rochelle Junction. This was completed and opened for business November 24, 1873.

After the opening of the branch in 1873, the Morrisania Steamboat Company made regular connections at Harlem river with their boats "Shadyside" and "Harlem," stopping at Astoria, Grand St. and Fulton St., to let off and take on both passengers and freight. The accommodations at Harlem river consisted of 6,700 feet of track, or 1.27 miles, seven frogs and seven switches, a round-house with five stalls (enough to house five engines), and a combination passenger and freight station, which was built on the river front, between Willis and Lincoln Aves. The whole working force at Harlem river consisted at that time of five men, and the local freight business consisted of an occasional shipment of brewers' grain and a few kegs of beer. Four trains were run each way daily, except Sundays, between New Rochelle Junction and Harlem River, three of which were passenger trains and the fourth passenger and freight, or a mixed train. Considerable passenger business was diverted from the main line at New Rochelle Junction, to New York, by way of the branch, on account of the novelty of the boat ride from Harlem

* From a paper in "New York Railroad Men," in 1896, by Mr. W. E. Chamberlain Assistant Superintendent of the New York Division of the New York, New Haven & Hartford Railroad.

River, and more especially since passengers made quicker time to the lower part of the city than by way of 42d St.

The freight continued to increase daily, but Harlem River as a freight terminal did not come into prominence until the early part of February, 1875, when the sound was frozen over so that the New Haven Steamboat Company could not run its boats, but put into Harlem River and unloaded their freight, which was taken to New Haven by rail. This was then considered a large amount of freight, and so surprised the five employees at Harlem River that they did not know what to do with it on account of the small facilities; and on February 11, Mr. A. M. Smith, who was sent from New Haven with a gang of freight handlers, arrived and found three of the New Haven Steamboat Company's boats at the station docks, waiting to unload; and before the first boat had been unloaded, every inch of available space in the freight-house was filled, and some delay was experienced in waiting for freight cars to arrive so as to finish the unloading of the boats. Freight cars arrived, however, and twelve were put in position as soon as possible, and the work of loading them continued. After the Sound opened, the New Haven boats resumed regular trips to New Haven.

About this time the New Haven Railroad Company was preparing to do a local freight business by way of Harlem River, and was building a freight-house on Pier 50, East River, New York City, which was opened for business in 1875, the freight being transferred between Harlem River and Pier 50 in barges until the float bridge, which the company was building at Harlem River, was completed. They were also having some eight- and ten-car floats built, and on June 1 two eight- and two ten-car floats arrived, and the tugboat "Thomas A. Walsh" was employed to tow them between Harlem River and Pier 50. After the usual trial trip was made, with some of the officers on board, the floats were put into service, being towed down from Harlem River to Pier 50 in the morning and back again at night, with an occasional trip between. Up to this time no attempt had been made to work up a foreign (western or southern) through business to and from New England via New York City without breaking bulk, and it required the genius of a master mind to conceive the idea of the utilization of the Harlem River route and the practicability of so gigantic a scheme. At that time Mr. Charles P. Clark was general manager of the New York & New England Railroad (afterward president of the New York, New Haven & Hartford Railroad Company), and to him belongs the credit of opening up the through line to the South and West via Harlem River, without breaking bulk, by means of transfer car-floats and steamers.

In 1875 Mr. Clark, seeing the advantage to be gained for the New England Railroad by opening up this through route, organized the New England Transfer Company, for the purpose of transferring cars from the Pennsylvania Railroad to Harlem River, to be hauled to Hartford, Conn., by the New Haven Railroad and there delivered to the New England Railroad. It was difficult, however, to get anyone to believe that it could or would be done, or that there was anything in it; although it was admitted that they might get a few cars, it was generally doubted

if it would pay for the trouble, but Mr. Clark's faith was undaunted; he believed in the scheme, carried it through, and put it on a paying basis. In August of the same year the first peach train from the Delaware district was sent through to Boston by this route and was followed by shipments of freight from New England to the Centennial Exposition, about to be held in Philadelphia, in 1876. From that time to the present, thousands of carloads of peaches, berries, melons, garden truck and other perishable freight have been sent into New England annually over this same route, reaching as high as 150 carloads in a single day, in addition to the other freight.

Mr. Clark then conceived the idea of opening up a passenger business via this route so as to still more benefit his road, and for the purpose of carrying on this additional scheme bought the famous steamer "Maryland," which had been used to transfer troops during the war. The upper deck had been used for transferring cars, and the lower deck for carrying the troops, but Mr. Clark sent her to Boston to be thoroughly overhauled, remodeled and changed, so that the cars could be run on the lower deck to meet the new requirements. After the repairs were made, and while on the way from Boston to Harlem River, the steamer ran aground at Vineyard Haven in the storm of April 4, 1876, and after a hard struggle and a great deal of expense she was finally got off and safely landed at Harlem River, where she was fitted out to carry the celebrated Centennial passenger express train, which was put on during the Centennial Exhibition to run between Boston and Washington. She made successful trips until December 7, 1888, when she was burned to the water's edge at Harlem River. The iron hulk was sold and broken up. Mr. Clark immediately ordered the present steamer "Maryland," which is built of iron, and is running between Harlem River and Jersey City at the present time.

In 1878 the Star Union Fast Freight Line was established via Harlem River and put in operation to carry freight from all points east and west, and in the same year arrangements were also made with the Pennsylvania Railroad and its connections to receive and forward local freight by this route, and when Mr. Reed, vice-president of the New Haven road, was at Harlem River one day he said: "I should not be surprised if we should receive fifty cars a day!" In 1883 the Central Railroad of New Jersey and the Philadelphia & Reading road entered into traffic arrangements via this route, which was followed by arrangements and occasional trips to the Delaware, Lackawanna & Western road in 1885, to the New York, Lake Erie & Western in 1886, and by traffic arrangements with the Lehigh Valley road (local to Buffalo) in 1891.

When Mr. Clark left the New York & New England Railroad and became vice-president of the New York, New Haven & Hartford Railroad, he had his faith in the undertaking and was the means of the latter company's buying out the New England Transfer Company, thus placing the transfer business wholly in their hands. With this closer relation came his opportunity to develop the route, so that in 1892 the records show about 280,000 cars transferred at Harlem River. In the meantime the company had pushed further into the New England States,

absorbing the New York, Providence & Boston, Providence & Worcester, Boston & Providence, and the Old Colony Railroads and their branches; and also the Housatonic road, now known as the Berkshire division; thus practically making Harlem River the gateway into New England. In November, 1892, Mr. C. S. Mellen became connected with the New Haven road as second vice-president and general traffic manager, and from this time dates a more rapid increase of business via the Harlem River Route. The developments in the East somewhat affected the traffic of western lines to New England territory, which very naturally turned toward the gateway of Harlem River, and then followed in quick succession the enormous coal trade, the great grain trade, via the various fast freight lines and Great Lakes via Suspension Bridge and Buffalo; also traffic arrangements with the New York, Lake Erie & Western, and the West Shore roads, until the pressure at Harlem River became so great that the stoppage of half of one single day's business was more than sufficient to block the facilities of the place, and the perplexities of the problem will be appreciated perhaps when in connection with these facilities one considers the possibilities of fog, ice, storm and high winds, and only by careful and systematic management is it possible to keep the business moving.

In 1895 larger and more powerful engines were added to the equipment, longer and more cars to the train established, and instead of 50 cars a day, as prophesied by Mr. Reed, the average daily handling for 1895 was about 1,370 cars, or a total of nearly 500,000 cars for the year, the highest record for a single day being 1,995 cars. In the meantime it had become necessary to enlarge the Harlem River yard, and before making the improvement land had to purchased, which caused delay. This yard when completed will have a capacity of 2,300 cars. In addition to the room required for working purposes the leaders alone will require 4.90 miles, and a total of 16.49 miles of tracks, requiring 224 frogs, 207 switches, and 22 slip switches to operate it. Besides this, a new west-bound yard is being completed at Van Nest, a point about five miles from Harlem River, which is to be used as an auxiliary to the Harlem River yard, and will have a storage capacity of 1,800 cars, requiring 14 miles of track, 86 frogs, and 85 switches, the leaders alone requiring 2½ miles of track to operate it. Plans have also been approved for another auxiliary yard for east and west bound purposes at Westchester, a point about seven miles from Harlem River, or about two miles east of Van Nest yard, which when completed will have 31 miles of track, requiring 152 frogs, 152 switches and 10 slip switches to operate it, which will give it a capacity of 3,500 cars; the leads alone requiring seven miles of track, thus making the total yard facilities on the Harlem River Branch 61½ miles of track, requiring 462 frogs, 477 switches, and 14½ miles of lead tracks to operate them.

Meanwhile a constant improvement of the water facilities has been made to try to keep pace with the increased business, and at the present time there are being constructed a number of 17-car floats; while the present equipment at Harlem River consists of four float bridges, 10 transfer tugs, 2 steamers and 35 car floats, of various capacities. The

steamer "Maryland" is 250 feet long, 66 feet wide, with three decks. On the first deck, where the cars are carried, there are two tracks, having a capacity of 6 passenger cars, or 12 freight cars. The second deck has the dining room in which the passengers may take meals while *en route* to and from Harlem River and the Pennsylvania Railroad. The third deck is used as a promenade for passengers to observe New York harbor and the beautiful scenery. It would be of interest to note that there are two through vestibule parlor and sleeping car trains each way between Washington and Boston daily, affording passengers a pleasant boat ride of an hour, which breaks the monotony of car travel while on the "Maryland." The day trains are called the Colonial expresses, and the night trains the Federal expresses, leaving Washington at 10 a. m. and 7 p. m., and leaving Boston at 10 a. m. and 7:30 p. m. The steamer "Express" takes the place of the "Maryland" when the "Maryland" is undergoing repairs or there are more cars than she can carry, and when not in use in passenger service, the "Express" is used in freight service. The "Express" is 282 feet long, 60 feet wide, has three tracks, and will carry ten passenger cars or nineteen freight cars.

The car floats used in the freight transfer business between Harlem River and Jersey City are 246 feet long and 37 feet wide and have three tracks with a capacity of fifteen to seventeen cars, according to the length of the cars. The floats that are used between Harlem River and piers 45 and 50 in the local freight service vary from 180 to 231 feet in length and are 38 feet wide. They have a raised platform in the center with a canopy or roof. On each side of the platform is a track, giving the floats a capacity of eight to twelve cars each. These floats when at piers 45 and 50 really act as a local freight yard afloat, without switching facilities, giving a yard capacity equivalent to 600 cars in the business part of the city, the cars being unloaded and reloaded by trucks by means of the platforms on the floats (which run between the cars) while the floats are tied at the piers. The total capacity of floating equipment owned by the company is 450 cars.

It may be well to explain to some extent the operation of the lighterage part of the transfer system. In the first place, iron Howe truss bridges about 100 feet long, each containing two tracks, are used. A distinct code of day and night signals is operated from signal poles on top of these bridges, showing to the yard master at the upper end of the yard the condition of the bridges. One signal indicates when floats have arrived and are in the bridges ready for unloading; another indicates when floats have been unloaded and are ready to reload;; another indicates when the bridges are empty and ready to receive floats; another indicates which bridge not to occupy. There is also a code of whistle signals which is used by the boats when about to leave the bridges to call in other boats that are arriving or tied up at the docks. Under the water end of the transfer bridges are pontoons buoyant enough to carry the heaviest load passing over the water end of the bridges that connect with the steamers and floats while they are being loaded or unloaded. Racks forming the approach to the bridge are built similar to those used at ferry slips.

On each steamer and float are four toggle straps, or boxes so termed, made of iron, which are secured to the deck, the hole in each being about 5 inches deep and 6 inches wide. There are also four toggle boxes fastened to each bridge through which the toggle bolts, a piece of steel 4½x5 inches and 5 feet long, is pushed to connect with the toggle box on the steamer or float, thus forming a key practically locking the steamer or float to the bridge, and bringing the tracks on the bridges and boats in line. On each side of the water end of each bridge is a windlass or winch to which a rope about 3 inches in diameter and 12 feet long is fastened, and on the other end of this rope is a hook which is put into an eye on the steamer or float so that they are drawn up close to the bridge and held there securely while being loaded or unloaded. This is a similar contrivance to that used on ferry boats.

In unloading a float or steamer after it has been made fast to the bridge, a switching engine with a long push or reach car attached to the tender is backed down on the bridge and coupled on to the cars preparatory to handling them. On the two-track floats it is the custom to pull the cars on the first track half way off the float and towards the shore end of the bridge, and then leave them and go around on to the other track with the engine and pull the cars entirely off, coming back and coupling on to the cars first pulled and taking all ashore to the yard. When loading floats or boats the cars are run on half way on one side of the float and allowed to stand until the cars are put on the other track of the float, when the switch engine returns to the first track and completes the loading. On three-track floats the movements are somewhat similar, except that the cars on the middle track when unloading are coupled on to and pulled off last, and when loading the cars are loaded on the middle track first, the object being to keep the floats in trim, or on an even keel, to prevent them from listing during the process.

After the boats are loaded the record of the numbers and seals, as well as the condition of the cars, is taken by the bridge clerks, car inspectors and floatmen, the floatmen signing the bridge clerk's record if correct, and in case of a broken seal, the car is resealed and a record kept of it for future reference and a report made of the broken seal. Then a tug makes fast to one or two floats as the case may be and proceeds down the Harlem River, through Hell Gate and into the East River *en route* to the piers; or if to Jersey City, under the Brooklyn suspension bridge, around the Battery and into the North River to whichever connecting line the cars are going, where they are re-examined as to numbers, seals and condition, and if found correct, a receipt is given to the floatman, which he takes back to Harlem River, where it is registered and filed. The same mode of procedure is gone through with when floats leave foreign roads *en route* to Harlem River.

Harlem River station as a transfer for mixed loads is a very important point for New England freight. It is open doing business day and night, 365 days in the year, and the payrolls include over 1,500 names. That the Harlem River station is not very generally known to the public is a fact due to its geographical position. When it was opened it was outside the city limits, but to-day it is about the center of New York

City. In early days the steamer "Maryland" became so prominent in connection with the route as to hide completely the name of Harlem River station, and it is a matter of record that some of the western lines still bill freight to the steamer "Maryland" instead of to Harlem River station, printing their way bills accordingly, thereby continuing the original form of designating the route. This is also true on west-bound traffic; the name "Steamer Maryland" was given prominence in the card manifest form simply to designate the route, and that form is still in existence. I recall an example of a recent conversation with a yardmaster located at a prominent junction point in the East, in which he informed me that up to a very short time ago he had supposed that the steamer "Maryland" was the only means of transfer between Harlem River and the western lines and pier 50, East River.

APPENDIX D.

(The following is a discussion of the Committee's fourth annual report, which was accidentally omitted from the volume of Proceedings for 1903.)

Mr. Walter G. Berg (Lehigh Valley—by letter) :—The conclusions in the report, with the exception of the first one relative to cluster yard, are not general enough for adoption or are not particularized sufficiently so as to differentiate the leading conditions for each class of structure. Whether the subject allows of concise detail conclusions is doubtful. In the form as presented the conclusions compare with a proposition such as that all track rails should be 85 pounds. No member of the Association would adopt such a conclusion, not even if it were to read "about 85 pounds." On the other hand, it is plausible to assume that a general conclusion could be adopted, for instance, that "Tee" rails were the best rails for steam railroads and that the base should equal the height, etc. As a sample of particularization or differentiation of conclusions it can be assumed that a conclusion might be adopted, such as for instance that no track rails should be less than 60 pounds; that within certain limits for wheel loads, speeds and traffic density, the range of rails should be 60 to 70 pounds, 70 to 80 pounds, or 80 to 90 pounds. The conclusions relative to piers must be treated similarly, covering either generalities or else specifying the various conditions.

The length of a pier is generally dependent on local conditions. It is correct to emphasize that long piers are, as a rule, objectionable. This is not generally understood. The length of freight piers should preferably not exceed 600 feet. For special purposes, such as coal piers, ore piers, etc., a longer length, 800 to 1,000 feet, is indicated. Piers for the large transatlantic liners have to be about 800 feet long.

The width of slip or waterway between adjacent piers varies according to the class of service from 100 to 300 feet as the extremes. The

usual range is from 150 to 250 feet. A width of 200 feet can be taken as a general average. The width depends on the length of the piers, long piers requiring a wider slip so as to give better steerway and free space for boats to pass each other quickly. Further, the size of the water craft governs the width, as it is necessary to assume that a boat is lying at each pier, and there should be ample room left for a third boat to pass between them freely. In certain lines of service it is customary for lighters, barges, coal boats, floating elevators, etc., to lie outside of a vessel moored to the pier and in such a case the width of slip has to be widened accordingly.

The space outside of a covered pier between the building and the face of the pier, and similarly the distance between the nearest track on an open pier and the face of the pier, cannot be established at a fixed width. This space depends upon many conditions, such as the class of freight to be handled, method of transfer to or from vessel, variations of water level, free board or height of gangways of vessels, etc.

The plans of piers presented with the report are mostly typical of special conditions and are not suited for general adoption. This is notably the case in the coal pier, the open lighterage pier and the city station pier, illustrated in the report. There is no reference to terminal structures located on bulkheads or parallel with the waterfront. The coal piers described are for hard-coal conditions at the seaboard. The grain elevator described is for transfer from cars to vessels and no reference is made to elevators for transfer from boats to cars. The two-track open lighterage pier is only good for short piers with one vessel berth on each side, and the proposed 6-foot raised platform on the outside will prevent skidding freight out of cars down a plank to low barges. The question of two or more stories in a freight pier is dependent on local conditions. The station pier described should preferably be called a "city car float freight pier." It is a special local feature of New York City and should not be selected and emphasized as a specific class of railroad waterfront structure in general use.

The width of piers is dependent on the floor space required for handling, storing, assorting, assembling, transferring, inspecting, sampling or tiering the principal freight commodities expected to be handled. Also on the length of storage required on the pier, i. e., whether quick or slow transfer freight or long storage freight.

I have the following suggestions to offer:

(1) The length of freight piers should be preferably not over 600 feet.

(2) The width of slip or waterway between adjacent piers will vary from 100 to 300 feet, according to the class of vessels used, the length of piers, and whether lighters, barges, coaling boats, floating elevators, water boats, etc., will lie outside of a vessel moored to the pier. A width of 200 feet can be assumed as a general average.

(3) The width of the space between the outside of a pier shed and the face of the pier and the spacing between the nearest track on an open pier and the face of the pier depends upon the method of transfer, the principal commodities to be handled, whether the freight has to be

inspected or tallied in transit over the stringpiece, the height of free board or gangways of the vessels, and the variation of the water level.

(4) The width of covered lighterage piers will vary from 100 feet up. For quick-moving lighterage freight, especially in-bound to cars, the width should be about 100 feet. For lighterage freight subject to considerable delays, such as out-bound freight waiting for boats or for balance of cars of a special lot to arrive, or requiring assorting, assembling, transferring, or inspecting on the pier, the width should be from 125 to 150 feet. Where the exact future service cannot be defined, a compromise width of about 125 feet is indicated. There should be two tracks in a pit inside of the shed, so that shifts of cars can be made on one track without stopping the freight-handling gangs.

(5) The width of open lighterage piers will be from 30 to 100 feet, according to the number of tracks and space required between tracks. There should be from two to five tracks on the pier, properly cross-connected, the number and spacing being dependent on the length of the pier, the number of berths on each side, class of commodities handled, method of handling, mechanical transfer appliances, and whether space has to be provided for temporarily storing, assorting or inspecting freight on the pier.

(6) The width of export and storage piers is dependent on the best method of piling or the tiering length for the principal commodities handled and on the extent to which long storage has to be provided. The limits for width of pier would generally be from 125 to 150 feet. In special cases, where the storage feature takes precedence over trucking distance, piers up to 200 feet, or even a greater width, are indicated. There should be two tracks in a depressed pit on the pier level at the center of the building. Where the waterfront is limited or very valuable two or more storied pier sheds are warranted. Under certain conditions additional tracks in the second story may prove more advantageous than elevators or bag and barrel chutes.

(7) The design of coal piers for transferring coal from cars to vessels is dependent on the class of vessels, the elevation and ground available for the approach and the location of loaded and empty car yards, the volume of business, the amount of pocket storage required, the class of cars the coal arrives in, whether the coal is hard or soft coal, and whether it has to be screened and the screenings taken care of.

(8) The track arrangements at grain elevators should be of the very best, as otherwise the output will be seriously curtailed. The detail arrangements of the tracks at the elevator should be such as to allow shifts of cars to be made without stopping all work. Where possible the tracks should be arranged to feed cars in at one end of the building and out at the other. It is important to have an auxiliary yard close to the elevator for holding empty cars to be loaded in the case of a water-to-rail elevator, or for holding the various classified lots of loaded cars in the case of a rail-to-water elevator. To make the grain transfer a success, it is essential that all car movements shall take place at the right moment and that cars will feed to and from the proper section of the cluster or general yard to and from the auxiliary yards immediately at the elevator without interference from main line or other yard operations.

MR. WALTER G. BERG (Lehigh Valley—by letter):—The conclusions relative to piers in the fourth annual report of the Committee, as revised and recommended for adoption in the fifth annual report, are in good shape for adoption, with the following exception in regard to conclusion No. 4, relative to Export and Storage Piers: I recommend eliminating the sentence, "If the conditions and volume and character of the business warrant, there should be two floors, with two or three depressed tracks on each, these tracks to be connected by crossovers at convenient intervals to facilitate the movement of cars," and substituting the following: "There should be two or three depressed tracks on the pier level, connected in long piers by crossovers at convenient intervals to facilitate the movement of cars. If the conditions and volume and character of the business warrant, there should be two floors, and, under certain conditions, two or more depressed tracks on the upper floor will prove more advantageous than elevators or chutes." The Committee's clause aims to settle in one sentence the two questions under consideration, viz., the tracks and two-story buildings. The substitute clause in two sentences is clearer, the first sentence relating to tracks on one-story buildings and the second sentence taking up two-story buildings.

In regard to the "new matter" presented in this fifth annual report, I have the following remarks to make:

The handling of cabooses in yards is always one of the problems in a yard design. I have seen a number of solutions, both in practice and on paper. Where there is a gravity grade, incoming cabooses are cut loose and turned by a flying switch into a gravity caboose holding track. Outgoing cabooses have been put on a hump yard track, the scheme being to drop them by gravity and turn the caboose in to the track on which its train stands ready to depart. These schemes are all dependent on topographical conditions largely and on the theory that the cabooses leave in the order that they arrive. The best designed scheme, after all, requires a switching engine or the road engine to transfer the caboose, and in such case the assembling or storage track for the cabooses should be, if possible, located so as to be convenient to the yardmaster and point where the men congregate and hang around. I agree, however, with the Committee that in small layouts the most suitable location of the caboose tracks, so as to avoid undue switching, will generally be anyhow fairly convenient to the yard headquarters, while in large layouts, such as the Committee reported on, there will be assistant yardmasters at different points of the layout in telephonic service with the main office. Hence the most important element is to locate caboose tracks so as to be convenient for switching and transfer of cabooses, incidentally keeping in view the desirability of easy communication with the yard headquarters, but not considering the latter point as an absolutely governing factor.

In regard to "Coal Piers," the Committee presents the best analysis,

classification and summary of up-to-date practice for coal piers designed for handling coal from cars to vessels that has ever been published. It is clear and comprehensive, and the criticisms or points pro or con the various systems listed are correctly stated.

More emphasis should be placed on the differences existing as between soft and hard coal shipments, the latter as a rule requiring screening in passing from the cars to boats, which question involves not only the introduction of screens and a slower feed over same, but also the storage and ultimate disposition of the screenings, and, in some cases, even the repreparation of the screenings so as to separate same into the marketable finer sizes. The storage, handling, weighing and disposition of screenings on a hard coal pier influence the design to a much larger extent than usually understood. There are many hard coal shipping piers in which the provisions for proper screening are inadequate or the coal is rushed over short screens so fast, and in such a deep layer, as to satisfy only the legal or contract of sale requirements that the coal is to be screened on its way from the cars to vessel.

In regard to the reduction of breakage, much has been accomplished by substituting the vertically movable apron with vertical feed box back of same in place of the old-style fixed apron. The vertical drop, however, from the end or lip of the apron into the hold of the boat still remains for the majority of designs where a large number of chutes are located along the side of the pier. Where the system employed is to bring the cars to one dumping point and to shift the boat to suit, in other words, a concentration of mechanical apparatus, such as used in the various styles of "car dumpers," the addition of a telescopic leg or suitable device, handled by machinery, can be introduced to lessen the vertical drop of the coal from the lip of the apron into the hold. There have been many devices tried and patented with an idea of producing the same results with simple means at each fixed chute of a high gravity coal pier, as usually designed, but as a rule they have been discarded and not found desirable; in some cases being too cumbersome and slow, in other cases wearing out too rapidly, and in other cases, where the design was fairly meritorious, the devices have been declared a failure, due to the non-insistence of the coal pier management that they should be used. The question is somewhat of a commercial one, in which the ownership and sale conditions of the coal and the charter requirements of the vessel play an important part. In some cases quick release of vessels, a large pier tonnage daily average shipment and reduction of the pier operating expenses will be more important to the railroad interests than the loss in value of coal to the customers, due to the breakage. In other cases, if the railroad interests are involved, the degradation of the coal due to increased breakage in dropping into the vessel and the subsequent extra expense of the reprepa-

ration of the coal so as to make the breakage salable is most important to consider.

The, so to say, greater ease with which a heavy telescopic leg, or bucket operated by power, can be installed in connection with a mechanical car-unloading machine has been advanced as a point in favor of car-dumping systems in place of high gravity piers. This is correct, nevertheless this is only one element of the car-dumping system. I consider it much more desirable to aim to have gravity coal piers, wherever the topographical conditions will allow it, with vertical feed boxes at the chutes and vertically movable aprons, and then for engineers and inventors to seek to reduce the breakage from the end of the apron into the hold of the vessel by some simple and economically operated device.

In regard to piers where coal is handled by machinery, it can be stated that, in particular cases, conveyors may be indicated, due to congested and local conditions, but that same should not be adopted excepting as a last resort, and, if so, then a belt or bucket conveyor is far superior to a scraper or spiral conveyor.

Car-dumping machines have been used very successfully along the lakes and are a development of the conditions existing at the lake shipping ports, but sweeping conclusions should not be drawn too hastily as to their efficiency and success under all conditions, especially for hard coal shipping piers at the Northern seaboard. Car-dumpers for small coal cars have been used in Europe for many years, but American ingenuity and inventive skill has improved on the European designs and turned out quick-acting machines of the capacity necessary for handling our large coal cars. The conditions along the lakes that gave rise to these machines were limited pier and terminal space in the small river harbors of the lake ports, shipment of soft coal largely in non-hopper-bottomed cars, the absence of the necessity for screening the coal and taking care of screenings, and the closing down of the shipping operations in winter. At our Eastern seaport terminals the conditions are different. The harbor or river frontage generally allows long piers to be built, the coal is practically all shipped in hopper-bottomed cars (which do not have to be turned over to be unloaded), the operation continues in winter, and, in hard coal shipments, screening is generally a trade requirement.

Assuming that the local conditions would allow a high gravity pier (either with inclined plane or locomotive grade approach) and with suitable loaded and empty yards to be built, the question of whether to adopt same or a car-dumping system turns largely on the following points: (1) Relative first cost; (2) operating expense; (3) speed or shipping capacity; (4) maintenance expense; (5) necessity for simultaneous shipments to several vessels; (6) greater freedom from delays due to breakdowns, car derailments or frozen coal in cars; (7) movement of cars to and from pier; (8) fixed force or number of trained operators and mechanics required, a number of whom are generally retained, even in slack seasons; (9) number and class of trained help

or mechanics required, making it more difficult to quickly increase the force in case of sudden change of trade conditions, a temporary rush or night turns being required; also greater liability to have operations stopped, due to strikes, inability to get substitutes, and trouble with labor unions; (10) for hard coal shipments whether efficient screening can be provided without limiting the shipping capacity, and whether screenings properly handled and disposed of; (11) elimination of coal breakage.

Most of the above points are generally considered in any careful weighing of the comparative value of the two systems, excepting that points (8) and (9), relating to the number of trained men required, are very seldom given the importance they deserve. A high gravity pier, especially with all gravity or locomotive grade approach, is operated by common labor, with ordinary labor bosses, weighmasters, and clerks. This class of labor and superintendence can be knocked off at any time and, when required, re-employed or other men found more readily, and thus sudden changes of trade conditions, rush shipments, night turns, strikes, etc., can be taken care of much better and economically than if a larger number of trained men are required to run the various mechanical plants.

The success of the car-dumping systems along the lakes is due to the local and operating conditions, as outlined above. The patentees of these machines have for a number of years been endeavoring to introduce this system at Eastern tidewater hard coal shipping piers, and hence the description of the coal pier of the Delaware, Lackawanna & Western Railroad at Hoboken, N. J., with car-dumping machines, now nearly ready for operation, as described in the Committee's report, should be of the greatest interest to all engineers and railroad officials concerned in the shipping of coal. If after a sufficiently long test period the Hoboken pier should prove successful from every standpoint in handling hard coal under Eastern tidewater conditions, there is no doubt that it will be pointed to as a pioneer in the development of coal pier systems of the future and prove one of the most advanced and radical steps that have been taken in this direction for years. The success of a mechanical plant, however, can only be demonstrated after a number of years, and all conditions, some with very far-reaching results and yet only indirectly connected with the problem, must be duly considered.

There is a question connected with coal piers that the Committee has not touched on, namely, the proper class of material to use in the structure, more particularly in the superstructure, whether steel, untreated timber or treated timber should be used. The renewal of a coal pier due to decay of the timber structure is very expensive, as so much machinery, chute-linings, etc., has to be dismantled and, when once disturbed, a large proportion of such fixtures and machinery cannot be used again. The question is in how far is the cost of timber treatment warranted, and also whether steel structures are adapted to the service. The only coal piers built with steel superstructure that I know of are the two steel soft coal piers of the Norfolk & Western Railway at Lamberts

Point, Norfolk, Va., described and illustrated in the Committee's report, and also the structural steel frame work of car-dumping machines. Steel coal pockets have also been used at a number of industrial plants. It would be desirable to get the views of the members of the Association on the subject of the best class of material for coal piers.

The Committee report does not state the leading features governing the selection of a "barney" or of a "continuous cable" for inclined planes. For a very heavy and steady service, such as at a large coal pier, the continuous cable system is quicker and gives a larger output, but it is more liable to cause accidents by drawbar gearing breaking or being damaged. Cars should be carefully inspected after going over such a plane before being run into the road service again. The barney system is safer than the continuous cable system, but is slower; the gradient of a barney incline can be much heavier, however, than for a continuous cable.

As a general proposition, a continuous cable should be used at large coal piers with a heavy service, lightening the incline gradient as much as possible, and inspecting the drawbar gearing carefully before and after the car goes over the plane. A barney system should be used for small plants, like local coal yards or coaling stations, etc., where the daily uptake requirements are limited, the service not big enough to warrant keeping car inspectors, and usually a heavy incline gradient necessary on account of limited property.

Finally, it might be desirable to call attention that the choice of gradients in any part or full gravity system is one of vital importance, especially where automatic switch back gravity movements are to be made. As a rule, it is seldom that gradients are struck which will work well all the year around under all conditions. Frozen cars will stick in winter, and it is good practice to arrange for a winch head and rope pull, either operated by hand, electricity or steam (if convenient), for use in emergencies at such points as the leader tracks approaching the pier and at switchback tracks on the pier. The Committee refers to the use of a pivot table, arranged to work automatically by means of a counterweight, so as to shorten the dead space lost at the end of a pier by a switchback and simplify the transfer of cars to the return track. Such pivot tables are in use at the Lamberts Point piers, but the table is "automatic" only in the sense that no steam or electric power is needed to move same, the down movement of the table being accomplished by gravity, the return by the counterweight, the whole being under control of a colored gentleman, who controls the brake levers.

MR. H. R. TALCOTT (Baltimore & Ohio—by letter):—For some years the Seattle Coal & Iron Company operated an hydraulic hoist, which, with a 30-in. piston, using water from the city mains, raised cars loaded with coal to the top of their retail bunkers.

Some weeks ago, when discussing the plans for a coal and ore pier designed to have pockets for both discharging into steamers at the sides and into cars under the center of the pier, it occurred to me that an hydraulic hoist could be used to *lower* the empty cars, vertically, to below

the pockets and save the space that would be cut out by a return incline from the end of the pier.

The hoist would be regulated by a gate valve, set below the water surface, through which the water would be drawn into the piston casing as the piston and empty cradle were drawn up by counterweights, and by which the descent with the empty cars would be regulated.

By using a rigid frame on the head block of the piston and a pivoted cradle for the cars on that, the weight of the car could be made to release the pressure from the chocks, to allow them to be withdrawn easily for lowering, and a suitable block at the bottom would tilt the cradle and discharge the empty car.

DISCUSSION.

Mr. W. G. Besler (Central Railroad of New Jersey):—Your Committee wishes to call your particular attention to the supplementary report in Bulletin No. 48, which contains corrections and changes in the preliminary report sent out in Bulletin No. 44. In addition to the corrections which you will find therein, the Committee wishes a further correction made in its conclusion No. 6, headed "Station pier and team-track delivery," i. e., eliminate the words "and team-track delivery." This will make conclusion No. 6 cover only "station pier." The attention of your Committee has been called to the definition of the word "yard," as adopted by the American Railway Association, and which differs from the definition of this word as adopted by this Association. The definition as given by the two associations is as follows:

American Railway Association: "Yard.—A system of tracks within definite limits provided for the making up of trains, storing of cars and other purposes, over which movements not authorized by timetable or by train order may be made, subject to prescribed signals and regulations."

American Railway Engineering and Maintenance of Way Association: "Yard.—Three or more parallel tracks arranged in series for the convenient storing or switching of cars."

The definition as adopted by the American Railway Association covers not only the physical property itself, but also the matter of its operation, and deals, therefore, with a matter with which this Association is not directly concerned.

There can be no objection, however, from the standpoint of our Committee, and in order that uniformity may be conserved, to adopting as our definition of the yard that adopted by the American Railway Association, if it is the wish of the Association so to do.

You will note that the preliminary report sent out in Bulletin No. 44 brought out some written discussion and some very valuable thoughts and opinions, and I would call attention to the fact that in the written discussion the writers took the matter into fields other than the province of this Committee on Yards and Terminals, and which more properly belonged to Committee No. 15, on Iron and Steel Structures, or perhaps Committee No. 6, on Buildings, or Committee No. 7, on Wooden Structures. These committees have to do with the design of the towers and buildings and various trestles and structures upon which your Committee on Yards and Terminals will endeavor to lay some tracks and give some

facilities for the transaction of terminal business. In the written discussion presented by Mr. Berg I would call attention to his suggestion that we eliminate in conclusion No. 4 the sentence: "If the conditions and volume and character of the business warrant, there should be two floors, with two or three depressed tracks on each, these tracks to be connected by crossovers at convenient intervals to facilitate the movement of cars," and substitute therefor: "There should be two or three depressed tracks on the pier level, connected in long piers by crossovers at convenient intervals to facilitate the movement of cars. If the conditions and volume and character of the business warrant, there should be two floors, and, under certain conditions, two or more depressed tracks on the upper floor will prove more advantageous than elevators or chutes."

The Committee is willing to accept the suggestion if the Association wishes it adopted, but believes that the construction as presented is quite clear and not liable to be misinterpreted.

The Committee submits its report and recommends its adoption.

The President:—What is the will of the convention as to the manner in which we shall consider the report? Shall we take it up under (a), (b) or (c) of Rule 5? I think we should consider it under (b), taking up the conclusions separately and discussing them.

Mr. W. M. Camp (Railway and Engineering Review):—I move we take up the conclusions separately and also give attention to the points mentioned by the chairman of the Committee.

(The motion was carried.)

The President:—Conclusion No. 1 is on page 56 of Bulletin No. 48. The Secretary will read the conclusions.

The Secretary:—"Piers.—At rail and water terminals, the piers should be designed with a view to the most efficient, rapid and economical handling of the business, and with a view also to the future development of this business. Care must be taken to give due weight to the special conditions and features of location, traffic, etc., which exist in every case, and which render it impossible to lay down any but the most general rules for such piers. In every individual case, the length, width, number of tracks, width of platforms, details of construction and width of waterway between adjacent piers must be adjusted to meet conditions as to shape and area of site, as well as its relation to its approaches from both land and water, the character and volume of the business and the manner in which it is to be handled."

The President:—That conclusion lays out some lines for our guidance that possibly may not agree with the experience of other members, and we would like to hear from them.

(The conclusion was adopted without discussion.)

The Secretary:—"Covered Lighterage Pier.—When conditions will permit, present practice will generally suggest a length of approximately 600 feet, with two depressed tracks. If the business to be handled over the pier is expected to move quickly, the width should be no greater than is necessary to provide temporary storage and shelter for the goods during ordinary detentions while waiting for cars or lighters, preferably about 100 feet. If the movement is expected to be slow, and it is neces-

sary to provide storage while waiting for cars or vessels, or for assorting, classifying, inspecting or sale of goods, the width should be increased, but generally not beyond a width of 125 to 160 feet. If the movement is not expected to have a special character, or a mixed business is to be provided for, a compromise width of 125 feet is suggested. The space between the shed and the outer edge of the pier should be not less than two feet, and the clear width of waterway between piers should be, if possible, not less than four times the width of the largest vessels to be handled."

(The conclusion was adopted without discussion.)

The Secretary:—"Open Lighterage Pier.—This should, if possible, have a length of about 600 feet, and the width, number of tracks and the appliances for handling traffic should be adjusted to the particular use to which the pier is to be applied. On long piers, crossovers may be necessary. For ordinary coarse freight in bulk, such as iron ore, stone, timber and similar products, the width should be from 50 to 80 feet, and there should be four tracks, with crossovers, to facilitate the handling of cars and avoid delay in transferring to or from vessels. If the business is light, or is principally heavy or costly products, such as cut stone, machinery, or miscellaneous freight not requiring shelter, a narrow pier of about 35 feet in width, with two tracks only, is suggested."

(The conclusion was adopted without discussion.)

The Secretary:—"Export and Storage Pier.—This should be designed with special reference to the character of the commodities to be handled, whether quick movement is expected or the goods are to be held some time in storage for the accumulation of full cargoes, or for inspection or classification. There should be two tracks in a depressed pit on the pier level, which, on long piers, should be properly connected by crossovers at convenient intervals to facilitate the movement of cars. On very wide piers additional tracks on the pier level are desirable under certain conditions. Where the water front is limited or very valuable, and the conditions, volume and character of business warrant, pier sheds of two or more stories, with platform or barrel elevators and bag or barrel chutes, are used. Under certain conditions, additional tracks in the second story may prove more advantageous than elevators. The length should be sufficient to properly accommodate either one or two vessels on each side at the same time, or approximately 600 to 1,400 feet. The width must be determined by the space available and the business to be handled. If quick moving, a width of 125 to 150 feet is recommended. If slow moving, and large accumulations must be received and stored, the width may be extended, if space permits, to 300 or even 400 feet, but excessive width is not recommended, on account of the consequent increase in cost of handling. The space between shed and face of pier should not be less than three nor more than six feet, and the clear waterway between piers should be, if possible, not less than four times the width of the largest vessels to be handled."

The President:—Any discussion on conclusion No. 4? We take it that the members have gone over this report very carefully, and that they

are allowing these conclusions to be adopted with full knowledge of what they contain.

(The conclusion was adopted without discussion.)

The Secretary:—"Coal Pier.—This should be an open pier, and where coal is to be delivered to vessels through pockets and chutes, in the ordinary way, the pier should be high enough to allow coal from drop-bottom cars to be loaded by gravity into vessels or barges. It should have three or more tracks, the outside tracks for loaded cars and the inside one on an incline to return the empty cars to the yard by gravity. The length depends upon the grade necessary to reach the desired elevation, the length of the vessels to be coaled and the number of cars which it is desired to unload at one time. Adjacent piers should be sufficiently distant to accommodate the class of service, which will depend on the length of the pier and the size of the water craft to be accommodated. Where coal cars are dumped by machinery which elevates and tilts the cars, a high pier is not necessary, and it may be at any convenient height."

The President:—Is there any discussion on conclusion No. 5? It is assumed, I suppose, in this conclusion, that all coal will stand dumping, though I have heard of some that would not.

(The conclusion was adopted without discussion.)

The Secretary:—"Station Pier and Team-Track Delivery.—A city station pier served by car floats should be approximately 600 feet long and 125 feet wide, with a 35-foot depressed driveway in the center. It should be a closed pier, with three-foot platform outside. Adjacent parallel piers should be, if possible, 200 feet apart in the clear. Along the water street should be a bulkhead, approximately 50 feet wide, with two-story building, the upper floor being for offices, fruit auction room, etc."

The President:—Members will bear in mind that the title of this conclusion has been changed and stands as "station pier."

(The conclusion was adopted without discussion.)

The Secretary:—"Grain Elevators.—These should be so located that cars can be run into them and loaded or unloaded, the tracks being so located that cars will feed to and from the proper part of the cluster or general yard without interference with other movements. The tracks should be arranged to feed cars in at one end and out at the other. Where this cannot be done, the tracks should be arranged so as to allow shifts of cars to be made without stopping all work."

(The conclusion was adopted without discussion.)

The President:—That appears to cover all of the conclusions recommended by the Committee, but there were some points which the chairman of the Committee wished us to take up, and we will ask him to state them.

Mr. Besler:—The only point which has not been covered is the one concerning the definition of "yard" as adopted by our Association versus the one given by the American Railway Association; and your Committee, as has been stated, has no objection, if the Association desires

to do so, to changing our definition to conform to that of the American Railway Association, in order that uniformity may be conserved.

The President:—It does not appear that it is absolutely necessary that we should make the change. One definition is from the standpoint of an operating official and the other from the standpoint of a maintenance of way official, and it is a question for the convention to determine whether they want to change it or not.

Mr. Walter G. Berg (Lehigh Valley):—What committee recommended what is known as our definition—the Committee on Yards and Terminals?

Mr. Besler:—Our definition is the Maintenance of Way Association definition. It was adopted by the convention some two years ago.

Mr. Camp:—The definitions which the Committee on Yards and Terminals has been using were not adopted conclusively. They were presented in 1901, and those who were present at that meeting will recall the vigorous discussion of them, because the convention was not at all satisfied with the definitions of the terms "yard" and "cluster." The convention was about to return that report back to the Committee for further consideration when the chairman proposed that the Committee could not go further in its work without a basis to work upon, and that it be permitted to use these definitions until some future time, when they might be further considered. The convention was not at all satisfied with the definition of "yard," did not think it covered the ground broadly enough, and the term "cluster" has been qualified in subsequent reports, by this same Committee, by the term "general yard," in order to indicate clearly the meaning of the term. It was a new term, proposed by the Committee at that time, and whether the Proceedings show that such was the case or not, it was the understanding at that time that the definitions were accepted provisionally.

The President:—The gentleman's statement is entirely correct as to the facts in the case.

Mr. Berg:—I recall the circumstances of the action of this convention three years ago, as to the proposed report on definitions relating to yards, and I move that this question of the definition of yards, and also the definition of other terms reported on heretofore provisionally by this Committee, be taken up by the Committee during the coming year, with the idea next year of presenting to us a systematic definition of terms connected with yard operations. I think that would probably be better than to attempt to settle the definition of yards to-day in a hurried manner—that the Committee on Yards and Terminals make a recommendation on the matter in its report next year, unless the Committee is ready to do so now.

The President:—I understand your motion is that the Committee, having used these terms for three or four years, is now in a position to say whether they are proper or not, and if not, to present a new set next year.

Mr. Berg:—Not only these, but all those heretofore reported by the Committee, so as to present a systematic code of definitions for review.

Mr. Besler:—I suppose we shall find the same diversity of opinion if we attempt to discuss the term "cluster" to-day as there was three years ago. The Committee has used "cluster" and "general yard" always together, so that you could, in a manner, pay your money and take your choice. I do not believe the Committee would be prepared to-day to give you any light on the subject.

The President:—It is moved and seconded that the Committee revise its definitions at the next annual meeting.

(The motion was carried.)

The President:—The report of the Committee on Yards and Terminals has been adopted, and the Committee is now dismissed.

Mr. Besler:—Before the Committee is relieved, I should like to have the Association express itself, if it cares to do so, as to any particular line of work it would like the Committee on Yards and Terminals to develop in the next year. Perhaps there might be a sufficient number of members who would like some particular line developed to make it profitable for the Committee to work along those lines, rather than have the Committee select the subjects for itself.

The President:—I am sure the Board of Direction would like some suggestions as to what to outline for this Committee, and suggestions from the membership along that line would be very acceptable.

Mr. C. S. Churchill (Norfolk & Western):—I would suggest hump and gravity yards as a good subject.

Mr. Berg:—I want to suggest something similar to Mr. Churchill's suggestion, and that is a general report on the design of yards, terminal yards and division yards.

Mr. Besler:—That has already been reported on.

Mr. Berg:—In detail, with diagrams?

Mr. Besler:—Yes, with diagrams of terminal, intermediate, break-up and make-up yards, and assembling and despatching yards.

The President:—We will understand that the Committee is instructed to consider hump and gravity yards in its next report.

REPORT OF COMMITTEE NO. XI.—ON RECORDS, REPORTS AND ACCOUNTS.

To the Members of the American Railway Engineering and Maintenance of Way Association:

The Committee on Records, Reports and Accounts, in submitting to the Association its fifth annual report, calls attention to the fact that this report simply supplements the fourth annual report, which was prepared for submission to the Association at its annual convention in March, 1903. However, the fourth annual report, which was printed in Bulletin No. 34, issued in March, 1903, was not considered or discussed by the Association on account of lack of time; hence the report was not printed in the Proceedings.

The Board of Direction instructed the Committee to invite a free and full discussion of this report, and, if necessary, to make such a revision of its conclusions and recommendations as seem desirable in the light of the criticisms received.

During the past year the Committee has diligently prosecuted its work and has made a slight revision in its conclusions and recommendations, which, however, do not materially change the general trend of the report.

The Appendix contains a paper on "The Distinction Between Repairs and Improvements, and a Proposed Classification of Railroad Maintenance of Way Expenses," by Mr. Walter G. Berg; Bridge Inspection Methods, compiled by Messrs. I. O. Walker and Job Tuthill, and criticisms of the Committee's fourth annual report which have been received up to the time of the publication of this report.

CONDENSED STATEMENT OF MEETINGS OF COMMITTEE.

The first general meeting of the Committee was held in New York City on October 2, 1903, at the office of Mr. Walter G. Berg, Chief Engineer Lehigh Valley Railroad. The following members were present: Edwin F. Wendt, Chairman; Walter G. Berg, Vice-Chairman, and J. E. Turk.

The Committee was in session five hours and made a careful study of all the criticisms. It was decided to change some of the titles of the different blanks and to make other minor changes to meet the views of the critics.

The second general meeting of the Committee was held in Detroit on October 28, 1903, at the office of Mr. W. S. Kinnear, Chief Engineer Michigan Central Railroad. The following members were present: Edwin F. Wendt, Chairman, and W. S. Kinnear, H. A. Woods, E. K. Woodward.

The Committee was in session five hours, and thoroughly discussed

the general scheme of the report in connection with the criticisms received from many members of the Association.

It was also decided to appoint a subcommittee to confer with the American Association of Railway Accounting Officers and report back to the General Committee on plan for the proper subdivision of Additions and Betterment Accounts. The personnel of this subcommittee is as follows: Walter G. Berg, Chairman; W. S. Kinnear, H. F. Baldwin.

The third general meeting of the Committee was held in Chicago on November 23, 1903, at the office of the Association. The following members were present: Edwin F. Wendt, Chairman; W. S. Kinnear, H. A. Woods and E. K. Woodward. The Committee was in session about three hours, and took final action in approving the present report for printing in the November Bulletin.

SUMMARY OF CONCLUSIONS CONTAINED IN FORMER REPORTS WHICH HAVE NEVER BEEN ACTED ON OR APPROVED BY THE ASSOCIATION.

1900: No conclusions were formulated and no recommendations made.

1901: No conclusions were formulated, but on page 322 of the Proceedings of the second annual convention it was recommended that duplicate copies of record books and maps, particularly right-of-way maps, should be kept in quite widely separated localities, so that the trouble and expense of reproducing the same will be greatly reduced in case of fire or accident.

1902: No conclusions were formulated, but the following recommendations are found in the text of the Proceedings of the third annual convention:

(1) On page 363 it was recommended that bridges be numbered by location in miles and tenths or hundredths from one terminal running toward another.

(2) The labor report or time-book form shown on pages 384, 386 and 387 was suggested for use where the system outlined on page 406 was adopted.

(3) The Track Foreman's Monthly Material Report, illustrated on page 393, met the approval of the Committee, and it was recommended that a uniform blank of this character be used in the Track Department, and a blank of similar character and size be used in the Bridge and Building Department.

Since this blank was prepared the Committee has decided that the size of the same should be 8x13", instead of 8½x14".

1903: The report of the Committee was not considered by the convention, and hence, according to general rule, was not printed in the Proceedings; however, the report as printed in Bulletin No. 34 contained the following conclusions:

(1) Three definitions were submitted for consideration and adoption:

(a) Records.—Records consist of information or data in graphical, tabular or statement form, relating to the physical characteristics, condition, cost and such other information as may seem desirable for record.

(b) Reports.—Reports consist of the medium through which information is transmitted from a subordinate official to a higher official, and from which records and accounts are prepared or compiled in the filing office.

(c) Accounts.—Accounts cover all statements required to enable payments to be made for labor performed and material furnished, and all statements necessary in order to establish the detail, total and comparative cost of work and various classes of expenses.

(2) Specifications.—In general the majority of the blanks recommended by the Committee are 8x13", which is the standard size adopted after a very careful and thorough investigation.

(3) Ledger Accounts.—The position of the Committee was outlined as follows: "There being no agreement among maintenance engineers regarding the value of ledger accounts, the Committee feels justified in taking the position that the record of cost of annual maintenance for each individual structure is desirable and will prove valuable information if accurately and continuously kept for a long term of years, but does not think such information is absolutely essential, and, therefore, no special blank or form for the purpose is recommended for adoption."

(4) Bridge Office Records.—The Committee expressed its views in the following language: "Keeping in view the present work of the Committee, viz., the design of blanks specially adapted to Bridge Departments in general in all parts of the country, the Committee believes that an office bridge record book is so valuable, necessary and essential as to make it desirable to give the subject longer study, to the end that a blank may be produced which will be more complete and more generally applicable than the one herewith shown as Exhibit 'E.'"

(5) The following blanks for the exclusive use of the Bridge Department were prepared:

Daily Report of Foreman of Bridges.....M. W. 1000
Monthly Bridge Material Report.....M. W. 1001
Foreman's Diary—Bridge Department.....M. W. 1002
Bridge Department Tool Report.....M. W. 1003
Structure Report .....M. W. 1004
Bridge Inspector's Daily Report.....M. W. 1005
Monthly Bridge Inspection Report.....M. W. 1006
General Bridge Inspection Report.....M. W. 1007

(6) The general blanks of the railroad should be used in all departments, including the Bridge Department, as far as applicable.

(7) The Committee submitted simply for the information of the Association certain blanks for the compilation of information for record purposes, relating to physical characteristics of road, etc., marked Exhibits "D," "E," "F," and "G."

1904: See pp. 237, 238.

GENERAL PURPOSE OF THE REPORT.

The general purpose of the present report is to consider the various forms used in connection with records, reports and accounts of the regular Bridge Department of a railroad; to suggest to the Association for consideration and approval those special forms solely for a Bridge Department which are considered essential, together with such forms—complete in every respect as to size, title, ruling, etc.—as are recommended for adoption, and to collect, analyze and present to the Association certain forms as typical examples of certain classes of forms in use on some of the larger systems of railroads in America, which are not considered essential under all conditions, and hence are not recommended by the Committee for adoption.

HISTORICAL.

The history of railroad forms or blanks is an interesting subject, but the Committee has been unable to obtain any data bearing on this feature of the report, except as stated on pp. 243, 244.

ANALYTICAL.

Briefly stated, this report deals with the following subjects:

Definitions of records, reports and accounts; specifications of forms; report of Foreman of Bridges; monthly bridge material report; diary of Foreman of Bridges; tool report of Foreman of Bridges; structure report of Division Engineer; current bridge inspection report; summary bridge inspection report; general bridge inspection report; ledger accounts; record of physical characteristics of bridges; office bridge record book; trestle record book; pocket bridge record book; proper subdivision of additions and betterment accounts.

SPECIFICATIONS.

Under this heading the Committee recommends nothing except the title, general arrangement and size of forms.

BRIDGE DEPARTMENT FORMS.

REPORT OF FOREMAN OF BRIDGES.

Revised Form M. W. 1000 has been prepared and the title has been changed from Daily Report of Foreman of Bridges by striking out the

word "daily" to "Report of Foreman of Bridges." Such a report might be found necessary on railroads where the territory of the Master Carpenter is so large that otherwise he would not be able to keep in touch with his men; however, on smaller railroads, where the Master Carpenter is in close personal touch with his gangs, this report would be used only at such times as the gang changes its location from one structure or piece of work to another. (See revised Form M. W. 1000, p. 247.)

MONTHLY BRIDGE MATERIAL REPORT.

The Committee believes that this report is necessary, and revised Form M. W. 1001 has been prepared, which differs in only one or two respects from the form submitted last year.

In the upper left-hand corner the words "Gang or District" have been introduced to explain that the report covers only such material as may be found within the territory covered by a specific gang of men.

In order to keep a correct check on the materials distributed along the road this report is necessary, and, according to the system of handling reports outlined by the Committee, these monthly reports sent in by the different foremen of gangs would be compiled in the office of the Master Carpenter into a division report, which would show all the material within a Master Carpenter's territory. (See revised Form M. W. 1001, pp. 249, 250.)

FOREMAN'S DIARY, BRIDGE DEPARTMENT.

Some of the critics take the position that a foreman's diary, known as M. W. 1002, is unnecessary. The Committee has carefully considered this criticism and sees no reason to change its former decision that the use of a diary as a running memorandum is in the interest of accuracy and economy.

Objection is made that a printed form for this purpose is not necessary, as blank books could be used for the same purpose. This position may be granted, and yet the Committee believes that a printed form will in the end prove most serviceable, because it forces the foreman of the gang to systematically and regularly make a record of what material has been used.

Reliance on memory by the foreman is very unsatisfactory, and the practice of recording each day such material as has been used can not be too highly commended. Furthermore, the information contained in this diary is the basis of the monthly bridge material report made up by the gang foreman, and is also the basis of the structure report which is prepared in the office of the Division Engineer.

Finally, the use of the diary, according to the system outlined by the Committee, instead of the use of miscellaneous note books, would insure the preparation of the monthly bridge material report and the structure report, in an accurate and, therefore, satisfactory manner. (See revised Form M. W. 1002, pp. 251-255.)

BRIDGE DEPARTMENT TOOL REPORT.

It is the judgment of the Committee that Form M. W. 1003 needs no revision. The form is so designed that the report may be made up

monthly, quarterly or semi-annually, but from information received it is believed that the general practice in America is to require tool reports quarterly.

If special tools are received from or sent to other gangs or other divisions a special notation to this effect may be made on the report by the gang foreman. (See Form on pp. 258, 259.)

STRUCTURE REPORT.

This report has been variously criticised by the members who studied the report. Certain typographical errors in the form, which was shown on page 33 of Bulletin No. 34, have been eliminated, and revised Form M. W. 1004 is now illustrated.

The Committee believes, after carefully considering all the criticisms, that its position outlined in the last report is correct, viz., that this report is desirable.

Attention is called to the feature that this is a structure report rather than a bridge report, and should be used to cover structures of all classes, whether bridges, or box culverts, or arch culverts, or buildings.

Some of the critics hold that this blank should be prepared by the Master Carpenter, but the Committee reaffirms its former decision that such a report can only be prepared in the office of the Division Engineer, because he is the only officer who is in possession of complete data necessary for the preparation of this report.

Engineering expenses, freight charges, charges of the Transportation and Motive Power Departments, and expenses for labor of trackmen in connection with bridges, expenses for those portions of the work which may have been done by contract, etc., are recorded, not in the office of the Master Carpenter, but rather in the office of the Division Engineer, and on this account the Committee does not see how the report could be prepared otherwise than as outlined. (See revised Form M. W. 1004, pp. 262, 263.)

BRIDGE INSPECTION REPORT BLANKS.

The Committee has considered it desirable in regard to Bridge Inspection Reports to broaden the scope of and improve the recommended forms by certain minor changes, which, however, do not materially change the general trend of the report.

CURRENT BRIDGE INSPECTION REPORT.

Recommended Form M. W. 1005, change title to "Current Bridge Inspection Report," in place of "Bridge Inspector's Daily Report." (See revised Form M. W. 1005, p. 266.)

The purpose of this form is to force the inspector, whoever he may be, to record the fact that the bridge had been visited on a certain day and an inspection made, and serves as a record and also advice to his superior.

SUMMARY CURRENT BRIDGE INSPECTION REPORT.

Recommended Form M. W. 1006, change title to "Summary Current Bridge Inspection Report" in place of "Monthly Bridge Inspection Re-

port," and omit column for "Location," as this can be entered, where necessary, under the first column for bridge number. (See revised Form M. W. 1006, pp. 268, 269.)

The purpose of this form, when used only as an office form, is to summarize the daily or trip inspections during the month, and serves as a condensed record of same and advice to superior officers. If this form is used as the original field record, in place of M. W. 1005, it would be the only form required for current inspection.

GENERAL BRIDGE INSPECTION REPORT.

Recommended Form M. W. 1007, change title to "General Bridge Inspection Report" in place of "General Bridge Inspection." (See revised Form M. W. 1007, pp. 272, 273.)

A system much in use is for the field record to be kept in a blank book, or blank loose sheets, used with a patented binder in the form of a book. These notes are subsequently compiled and reported in a condensed form in a typewritten report.

Attention should be directed to the feature that the Committee aimed to emphasize throughout its report, that the recommended forms are intended to be elastic and adaptable to the varying conditions, whether the inspections are made by regular bridge inspectors, sub-officials, or higher officers, and whether the inspection is continuous, daily, monthly, quarterly or periodical, as it is a simple matter for each company to adapt the forms as presented to their particular requirements by a few minor changes in headings and notes. The forms are also adapted to reporting any class of structure. The recommended forms as revised, M. W. 1005, 1006 and 1007, are exactly the same as embodied in a report on Bridge Inspection of a Committee of the Association of Railway Superintendents of Bridges and Buildings, presented and received by that association at its annual convention, held in Quebec in October, 1903. Several members of that Committee are also members of the American Railway Engineering and Maintenance of Way Association.

During the past year your Committee has obtained more extensive information as to the use of the various types of bridge inspection reports, and submits the following as giving more complete data than contained in the original draft of the report.

Recommended Form M. W. 1005: A report form similar to this form is in use as a daily report by the Lehigh Valley Railroad. The Ohio River Railroad has a very similar small one-page letterhead size report turned in by the "bridge-walker."

Recommended Form M. W. 1006: A report form similar to this form is in use by the Lehigh Valley Railroad, Wabash Railroad and Lake Erie & Western Railroad. The Norfolk & Western Railway and the Rutland Railroad use a similar form for reporting inspection of culverts, pipes, pit cattle-gaurds, etc. The Oregon Short Line Railroad, Union Pacific Railroad and Chicago & Northwestern Railway use a similar form for compiling from the field inspection book a statement of bridges requiring renewal or repairs.

Recommended Form M. W. 1007: A report similar to this form is in use in book form by the Great Northern Railway, Atchison, Topeka & Santa Fé Railway, and Norfolk & Western Railway. The Norfolk & Western has, in addition, a separate large office form in separate sheets with similar headings and bridge data printed on left side, the inspection results and recommendations being filled in on righthand side. The Louisville & Nashville Railroad uses a large inspection report with bridge data printed on left side and wide blank columns for inspection report. The Nashville, Chattanooga & St. Louis Railway uses a similar small book form for field inspections, the bridge data being entered on left page and the inspection notes on the blank right page, excepting the right page is divided into four sections to allow the notes of four separate inspections to be entered before having to take a new book. The Intercolonial Railway uses a similar form, issued in large single sheets, 18x14 in., on the left side of which are 18 vertical columns for bridge data (practically bridge record sheet), and the balance of sheet for date of inspection and remarks, under which the condition is entered.

All bridge inspection reports which are typewritten without using a special form, and, further, the use of blank field books, can be, in a general way, classed as similar to Form M. W. 1007. While no special form is used, the method is the same, viz., to record name and leading characteristics of bridge and then follow with notes as to condition of bridges, material required, recommendations, etc., without attempting, however, to group the notes in columns.

In addition, the Committee presents for the information of the Association the following forms, as illustrating typical forms not covered in the recommended Forms M. W. 1005, 1006 and 1007.

Exhibit "A," Pere Marquette Railroad, Bridge Inspection Report, representative of type of individual sheet for each bridge inspected, with detail enumeration of items to be examined. The Boston & Maine Railroad uses a similar small report in book with stub. The Central Vermont Railway uses an individual report for each bridge on a large sheet, with a small number of side headings. The Southern Railway uses a single sheet for each bridge, folded, double letter-paper size, enumerating 48 items to be answered.

Exhibit "B," Canadian Pacific Railway, Bridge Inspection Report, representative of type of reports with a large number of detail items enumerated in side headings, and with a number of vertical columns for various bridges, and then on the right additional data as to any special item of any particular bridge. This blank is issued in book form for field use, 5½x9¾ in., and in sheets same as Exhibit "B," 8½x14 in., for office use. Similar blanks are in use in sheet form on the Wisconsin Central Railway. The Chicago & Northwestern Railway uses practically the same forms, issued in book form, 4¼x10 in., for field use, and in separate sheets, 8½x13½ in., for office use. The Duluth, South Shore & Atlantic Railway uses a similar book form, 4¼x9½ in. The Northern Pacific Railway uses a similar book, 5¼x9½ in., and office sheets, 8½x14 in. The Chicago & Northwestern Railway differs from Exhibit "B" mainly

on account of the omission of the two columns, "Bridge Number" and "Item;" the bridge number and item number have to be written by hand in the remarks column. The Oregon Short Line Railroad and the Union Pacific Railroad use a similar book form, about 4½x9¾ in., excepting the blank page for "Remarks" is ruled and columns provided for reporting in detail the condition of piles, caps, etc., of trestles.

Exhibit "C," Southern Pacific Railway, Report of Bridge Inspection, representative of type of large bridge report sheets with a large number of detail items enumerated and grouped in vertical columns. The Galveston, Harrisburg & San Antonio Railway uses a similar report. This sample is typical of similar reports in use on the New York Central Railroad, Pennsylvania Lines West of Pittsburg, Toledo, St. Louis & Western Railroad, Buffalo, Rochester & Pittsburg Railroad, Cincinnati, New Orleans & Texas Pacific Railway, Rutland Railroad, and Algoma Central & Hudson Bay Railway. On some of these railroads, for instance on the Pennsylvania Lines West of Pittsburg, Southwest System, on one-half of the sheet the bridge data are printed in considerable detail and in the order as the bridges are met in going over the road. In all of these reports the space left for notation under the vertical columns is very limited, and a system of special markings has to be adopted to indicate certain conditions.

Exhibit "G," New York, Chicago & St. Louis Railroad, Bridge Inspection for Trestles. The Southern Pacific Company uses a similar report in small sheets in pad form. The Toledo, St. Louis & Western Railroad uses a similar sheet report for trestle, 11x8½ in.

LEDGER ACCOUNTS.

The Committee sees no reason to make any change in its position as outlined under Conclusion No. 3 of the year 1903, which will be found on page 284.

BRIDGE OFFICE RECORDS.

The members who have submitted criticisms think that Exhibits "D," "E," and "F" show forms which are too large and unwieldy for convenient use. The Committee endorses this view and believes that printed blanks are not necessary on small railroads for reporting or recording this information, because such information is required only once or twice a year, and a suitable blank may be readily prepared by the clerical force.

However, large systems of railroads, having several grand divisions and many minor divisions, require uniformity in the methods of reporting information for the use of general officers, and on some roads printed pamphlets are distributed to the proper officers on the different divisions, to be filled in periodically with the desired information.

The current practice of railroads in this respect is variable, and, therefore, the Committee makes no recommendation regarding a printed form.

Exhibits "H" and "K" show printed forms used by the Pennsylvania Railroad and the Pennsylvania Lines West of Pittsburg for reporting general information pertaining to bridge records.

Regarding bridge office records, the Committee believes that to a large extent the economical working of the Bridge Department depends upon the completeness and accuracy of its records, and, keeping this fact in mind, as well as the proposition that every working Bridge Department is to some extent a part of the Chief Engineer's Department, the proper conduct of whose work is dependent upon accurate and complete bridge records, the Committee recommends that the general subject of bridge office records should receive further study before the Association is asked to approve any forms for reporting information.

ADDITIONS AND BETTERMENT ACCOUNTS.

Your Committee calls attention to the paper on "The Distinction Between Repairs and Improvements, and a Proposed Classification of Railroad Maintenance of Way Expenses," by Mr. Walter G. Berg, presented at our last convention and published in Bulletin No. 33 for March, 1903, and herewith presented as an appendix to this report.

Your Committee recognizes the great value of a systematic consideration of this subject as one of the leading questions affecting the analysis of railroad accounts. The detail distribution of the charges originates in the maintenance of way department and a proper and correct subdivision of its accounts is desirable so as to allow of a better study and analysis of the departmental expense. It is very essential that suitable and proper distinctions and divisions should be made between repairs and improvement work.

That the questions discussed in the paper are vital is clearly indicated by the attention given same in editorials in the technical and financial press, emphasizing the desirability of the adoption of some clear distinctions and uniform practice. Your Committee has also been informed that several prominent railroad systems of the country have committees of their financial officers working on this same question. There is no doubt that this subject is a live question of the day in railroad accounting.

In accordance with the instructions of the Board of Direction, the chairman of your Committee, on May 23, 1903, wrote to Mr. John W. Renner, president of the Association of American Railway Accounting Officers, stating that the Committee of Records, Reports and Accounts of the American Railway Engineering and Maintenance of Way Association had been directed to confer with his association and to report on a plan for proper subdivision of maintenance of way accounts, more particularly to the determination and classification of additions and betterments, and the distinction between repairs and improvements, and requesting consideration of the subject by the Association of Railway Accounting Officers and suggesting possibly a joint conference of sub-committees from both associations. Mr. Renner replied that the letter and question had been referred to the Executive Committee of his association at their annual convention during May, 1903, at Hot Springs, Va., which committee at a meeting in Chicago in November, 1903, referred the question to a sub-committee, consisting of Mr. J. W. Renner, president of the Associa-

tion of American Railway Accounting Officers, Mr. S. C. Johnson, General Auditor, St. Louis Southwestern Railway, and Mr. Jno. G. Drew, Comptroller, Great Northern Railway. Owing to this sub-committee of the Accounting Officers having only been recently appointed, your Committee has not been able to take up the subject with them, but will do so with a view to determining, in accordance with the desire expressed by Mr. Renner, in how far and along what lines the two committees could co-operate.

Your Committee presents the above as a progress report and requests to have the subject submitted to it for further report.

CONCLUSIONS.*

Your Committee submits to the Association the following conclusions and requests that action on the same be taken at the annual meeting in March, 1904:

(1) The following standard forms:

Report of Foreman of Bridges	M. W. 1000
Monthly bridge material report	M. W. 1001
Foreman's diary, Bridge Department	M. W. 1002
Bridge Department, tool report	M. W. 1003
Structure report	M. W. 1004
Current bridge inspection report	M. W. 1005
Summary current bridge inspection report	M. W. 1006
General bridge inspection report	M. W. 1007

(2) In bridge inspections there should be a clear distinction made between current inspection and general inspection. The purpose of the current inspection is to keep the structure in safe condition, to promptly discover any defects, and to report same promptly, so that repairs can be made before the safety of the structure is affected.

It is important that a simple record should be made while at the bridge and the superior officer kept advised of all such inspections promptly, whether made by a bridge mechanic, gang foreman, division bridge inspector, Master Carpenter, or others.

The purpose of the general inspection, frequently called the annual inspection, although in many cases conducted semi-annually, or even quarterly, is not only to check the maintenance work of the division organization, but to make a more careful investigation of important bridges and structures on the entire road, and, further, to ascertain and settle what extensive repair work or renewal work should be done in the following working season.

(3) The general forms of the railroad should be used in all departments, including the Bridge Department, as far as applicable; for example, one form for reporting time should be used in all departments, the blank being designed accordingly.

(4) Bridge records, etc., marked Exhibits "D," "E," "F," "H," "K." These records, when properly kept up to date in an accurate manner, will prove of the highest value to railroads, and are essential for any system of complete and proper bridge records. However, the Committee believes

*See amendments, page 286.

that such forms are not necessary specially for a Bridge Department, but are necessary generally for the compilation of records for several departments, and hence these forms are not recommended as standard special Bridge Department forms.

Furthermore, greater study should be given to the subject of bridge office records before any conclusion is finally formulated by the Committee for submission to the Association.

(5) Numerous minor forms are used on all railroads for reporting information necessary to keep bridge records up to date, but, in the opinion of the Committee, such forms should be regulated by each individual road according to its peculiar requirements, and hence no standard forms for this purpose have been prepared and none are recommended to the Association for adoption.

RECOMMENDATION.

Your Committee recommends to the Association for adoption the eight standard forms marked M. W. 1000 to 1007, which should be considered as the necessary special blanks required for the regular working of a Maintenance of Way Bridge Department.

Respectfully submitted,

EDWIN F. WENDT, *Chairman;* Assistant Engineer, Pittsburg & Lake Erie Railroad, Pittsburg, Pa.

WALTER G. BERG, *Vice-Chairman;* Chief Engineer, Lehigh Valley Railroad, New York, N. Y.

H. F. BALDWIN, Chief Engineer, Chicago & Alton Railway, Chicago, Ill.

M. L. BYERS, Assistant General Superintendent Transportation, Baltimore & Ohio Railroad, Baltimore, Md.

W. S. KINNEAR, Chief Engineer, Michigan Central Railroad, Detroit, Mich.

F. L. NICHOLSON, Engineer Maintenance of Way, Norfolk & Southern Railroad, Norfolk, Va.

F. W. SCARBOROUGH, Engineer Maintenance of Way, Chesapeake & Ohio Railway, Richmond, Va.

J. E. TURK, Superintendent, Philadelphia & Reading Railway, Tamaqua, Pa.

H. A. WOODS, Engineer in Charge Grade Reduction and Double Track Improvement, Grand Trunk Western Railway, Detroit, Mich.

E. K. WOODWARD, Engineer Maintenance of Way, Wabash Railroad, Detroit, Mich.

Committee.

FOURTH ANNUAL REPORT.*

The report now submitted to the Association is the fourth one since the formation of the American Railway Engineering and Maintenance of Way Association. It may be well to introduce the 1903 report by giving a short statement of the work done by the Committee in the past three years.

FIRST COMMITTEE REPORT—YEAR 1900.

The first report, submitted in the year 1900, was written by the Chairman, and contained an outline of what work the Committee should undertake. Previous to this report the Committee had held no general session.

The report laid particular emphasis on the necessity for accuracy in making up reports of all kinds, and to this end suggested that the blanks to be recommended by the Committee should be as few and as simple as possible. The following extract gives the keynote of the report:

"It is very important that reports of Accounts and Records of all transactions should be accurate, clear and arranged in a manner that admits of easy reference, for the records of the past furnish us the reliable means of estimating the future."

SECOND COMMITTEE REPORT—YEAR 1901.

The report of the Committee submitted to the Association in 1901 took up the following subjects:

(1) Labor Reports.
(2) Material Reports.
(3) Miscellaneous Reports.
(4) Records:
    a. Right-of-Way and Deed Records.
    b. Lease Records.
(5) Labor and Material Accounts.

THIRD COMMITTEE REPORT—YEAR 1902.

It was the aim of the Committee in 1902 to follow up the work of the previous Committee in accordance with what seemed to be its recommendation. The report considered the following subjects:

(1) Bridge Records.
(2) System for filing Reports, Records and Accounts.
(3) System for filing correspondence.
(4) Reports:
    a. Labor reports.
    b. Material reports used in the Track Department. No blank for the Bridge and Building Department was considered.

* Reprint of 1903 report.

c. Reports of sidings laid, taken up, shortened or extended.
d. Bridge reports. Under this head the Committee illustrated, page 396, Proceedings of 1902, a blank to be used in reporting the results of a bridge inspection.

Attention is called at this time by the Committee of 1903 to the fact that this blank was one used by the Baltimore & Ohio Railroad, but has been abolished during the past year. This was known as B. & O. R. R. form 1836, and, according to a letter received from Mr. J. E. Greiner, Engineer of Bridges, on October 16, 1902, this form was abolished after the Committee had made its report in 1902.

(5) Typical Form of Agreement for Side Tracks to Industries.

(6) Accounts.

(7) On page 402 of the 1902 Proceedings, the Committee made a certain suggestion to the Association, which, if carried out, would certainly have aided the present Committee very greatly in its work. This suggestion was to the effect that the Committee would be greatly aided in its work by the different members of the Association submitting to the Committee through the Secretary of the Association, from time to time, such questions as the members may think proper pertaining to matters arising in everyday practice regarding the general subjects of Records, Reports and Accounts. The suggestion was evidently not well taken by the Association, as during the past year the Committee has not received a single inquiry.

(8) Conclusions.

a. In 1902 the Committee illustrated a form of time book for use in the Track, Bridge and Building, Signal and other sub-departments of the Maintenance of Way Department. The book is designed to be made up by the foreman, then forwarded to the Supervisor, or Road Master, or Master Carpenter, or Superintendent of Bridges and Buildings, or Signal Inspector, and, after being examined and approved, forwarded to the office of the Engineer Maintenance of Way, or Division Engineer, or Assistant Engineer, where all payrolls are prepared.

b. Under the head of Material Reports the Committee recommended a blank 8½x14 inches to be used by track foreman in reporting material on hand, received, used, shipped away, etc. This blank is made up according to the same system as outlined for labor reports. (See inset sheet, page 393 of the 1902 Proceedings, for a full-size illustration of this report.) The Committee regarded this blank as one possessing much merit and worthy of general adoption.

c. It was recommended that the Committee continue its consideration of the general subject of Bridge Department forms.

FOURTH COMMITTEE REPORT—YEAR 1903.

The Chairman and Vice-Chairman of this Committee were appointed by the Board of Direction in the month of May, 1902. The original members of the Committee were selected by the Board in the month of June. The first meeting of the general Committee was held on Sep-

tember 15, 1902, at the Iroquois Hotel, Buffalo. Action was taken toward the enlargement of the Committee. A larger committee seemed necessary on account of the geographical location of the members, it being practically impossible to hold a meeting which would be attended by every member of the Committee. Certain new members were selected by the Committee and added to the same by the approval of the Board of Direction.

It was thought that a larger Committee would enable two sections, a western and an eastern, to be formed. This idea, while a good one, and one which meets with the approval of the Committee, was not carried out during the past year for good reasons, but it is probable that the work of the Committee in the future will be divided between an eastern and western section.

The Buffalo meeting was attended by three members only—Edwin F. Wendt, Chairman; George Houliston, Vice-Chairman; and J. E. Turk. In order that the work of the Committee might be outlined for the year in a proper manner it was ordered that blanks used in the bridge departments of the various railroads in America should be collected through the Secretary of the Association.

The second meeting of the Committee was held in New York City on November 10, 1902. The following members were present at the meeting: Edwin F. Wendt, Chairman; Walter G. Berg, F. L. Nicholson, J. E. Turk.

The work of the Committee was outlined for the year and three sub-committees appointed, as follows:

Sub-committee No. 1, to consider and recommend blanks for reporting material and tools on hand, received, used and shipped away—J. E. Turk, Chairman; E. K. Woodward, G. H. Webster.

Sub-committee No. 2, to consider and recommend forms to be used in reporting the results of the inspection of bridges—Walter G. Berg, Chairman; L. F. Goodale, H. A. Woods.

Sub-committee No. 3, to consider and recommend bridge record books and forms—F. L. Nicholson, Chairman; George Houliston, F. W. Scarborough.

After the sub-committees had prepared and submitted their reports, the preliminary draft of the final report of the Committee, which is now presented to the Association, was formulated by the Chairman, and subsequently a third meeting of the General Committee was held in New York on February 16, 1903, which was attended by Messrs. Berg, Turk and Wendt.

At this meeting the report was carefully criticized, and the conclusions and recommendations of the Committee formulated and approved.

A fourth meeting of the Committee has been arranged to be held in Chicago on March 16, 1903, the day preceding the next annual convention. By that time this report will have been printed, but in view of the fact that a large number of the Committee will probably find it con-

venient to be present, it was thought best to hold such a meeting for the purpose of discussing the future work of the Committee.

The Board of Direction very wisely limited the work of the Committee this year to three subjects:

(1) Definition of Terms.
(2) Specifications.
(3) Bridge department forms, to include labor and material reports, inspection reports and office records.

DEFINITIONS.

The Committee undertook to formulate definitions for three terms only, viz.: Records, Reports and Accounts.

Your Committee submits the following definitions for the consideration of the Association:

(a) RECORDS.—Records consist of information or data in graphical, tabular or statement form, relating to the physical characteristics, condition, cost and such other information as may seem desirable for record.
(b) REPORTS.—Reports consist of the medium through which information is transmitted from a subordinate official to a higher official, and from which records and accounts are prepared or compiled in the higher office.
(c) ACCOUNTS.—Accounts cover all statements required to enable payments to be made for labor performed and material furnished, and all statements necessary in order to establish the detail, total and comparative cost of work and various classes of expenses.

SPECIFICATIONS.

In the preparation of blanks, the Committee calls attention to the fact that close attention should be given to the following features:

(1) Class of paper.
(2) Color.
(3) Book form or sheets.
(4) Blanks should not be complicated.
(5) Blanks should be elastic and adapted to work of various classes.
(6) The amount of clerical work prescribed for foremen and subordinate officers should be reduced to a minimum.
(7) Blanks should be designed on the principle that the lower officers furnish the information from which the higher officers compile the records and work out such data as is required to inform the general officers as to the state of the company's property and its business.
(8) Blanks used by the lower grade of officers should be as simple and as small as possible.
(9) The size of blanks should be carefully studied in order to reduce to a minimum the waste of paper by the printer.
(10) Blanks used in the lower grades of the service should have

large spaces, both vertical and horizontal, while blanks used in offices employing regular clerks may have small spaces accordingly.

(11) Most of the blanks recommended by the Committee of 1903 are 8x13 inches, which is the standard size adopted by the Committee after a very careful and thorough investigation. The Committee adopted the size, 8x13 inches, on account of the feature that letter paper, legal cap and agreements are usually 8 inches wide and the larger sheets 13 inches in length; hence, in forwarding reports with letters and various summaries made on typewriting paper, the size 8 inches fits in with the papers without the edges being torn or requiring folding. Similar sizes, 8x13 inches, fit in with sundry statements of that length.

Attention is called to the feature that, while this size has been adopted by the Committee as standard, the blank may be changed in width and length to suit any standard size in use on the railroad. It is recognized by the Committee that a blank 8½x14 inches corresponds to commercial size of paper and cuts without waste, but for the reasons above stated the Committee recommends the 8x13-inch blank.

The Monthly Material Report Blank, specially for the Track Department, recommended by the Committee in 1902, report, page 393, was designed 8½x14 inches. Attention is called to the size of this blank, in view of the decision of the present Committee to use an 8x13-inch blank as standard.

BRIDGE DEPARTMENT FORMS.

The work of the Committee during the past year has been limited exclusively to Bridge Department blanks, which is the third subject assigned to the Committee by the Board of Direction.

The wisdom of the decision of the Board to limit the work of the Committee to one general subject has been fully demonstrated by the results attained. The subject is so important and of such general interest as to make it impossible for the Committee to have considered any other matters.

The previous Committee had begun the study of Bridge Department records, but found that it was not convenient to do justice to the subject and at the same time take up the other subjects which the Committee had under consideration at that time.

The preliminary study given to this subject in 1902 convinced the Committee that much good would be derived from a close study of Bridge Department forms, as there did not seem to be any uniform system of blanks in use in this country.

HISTORICAL.

The history of railroad blanks is not known to your present Committee. Diligent search has been made in the Carnegie Library of Pittsburg for some information bearing on the historical development of railroad blanks, but no literature was found.

The system of blanks now in general use in America has been the development of about seventy-five years; this time having elapsed between

the origin of railways as a transportation agency in 1820 and the present time.

In the early days of the railroad business, when roads were very short, with a very few locomotives, and a comparatively small number of employés, the number, nature and character of reports required from the officers were necessarily few. In many instances, one man was the head of several departments and was capable of overseeing everything personally, thus making it unnecessary to require an extensive report system.

As the business grew, and railways became more numerous and of greater lengths, a simple system of blanks would be required; however, it has been the work of recent years to formulate a system of blanks which are practically necessary, generally, to all railroads.

The formation of the Interstate Commerce Commission brought about the necessity for making uniform reports to this Commission, giving data bearing on numerous subjects. The adoption by the Commission of a uniform classification of construction and operating expenses made it necessary for the railroads to gather data which would enable them to make reports of earnings and expenses, in accordance with these standard classifications, hence it may be stated that during the past fifteen years much more careful attention has been given to this subject than heretofore, to the end that the necessary information for the general officers of railroads should be collected, analyzed and reported in the most economical, uniform and efficient manner.

At the present time the aim of all railroads is to adopt such a system of blanks as will promote uniformity in method and obtain the desired results with the least expenditure of money, the efficiency of the road from an operating standpoint being constantly kept in mind.

ANALYTICAL.

The general purpose of the report which the Committee now presents to the Association is to consider the various blanks used in connection with Records, Reports and Accounts, relating to the work of the regular Bridge Department of a railroad; and to suggest to the Association for its consideration and approval those special forms solely and distinctively for a Bridge Department which are considered absolutely essential, together with such forms—complete in every respect as to size, heading, ruling, etc.—as are recommended for adoption. Also to collect, analyze and present to the Association certain blanks as typical examples of certain classes of blanks in use on some of the larger systems of railroads in America, but not considered absolutely essential, and hence not recommended by the Committee for adoption.

It is necessary, in order that there may be no misunderstanding as to the interpretation of the report, to outline some definite organization to serve as guidance for describing the course of the various reports in passing from the Foreman of Bridges, the lowest person making a report, through the various channels to the record office.

ARGUMENT.

In presenting an outline organization for a Bridge Department, it is not the function nor the intention of this Committee to recommend any ideal organization, but rather to call attention to what seems to be the

usual organizations found on the leading railroads of America, viz., the Department System and the Division System, and to call attention to the fact that the blanks recommended can by slight change of heading be adapted to either system.

It is the function of the Committee on Uniform Rules, Organization and Titles to consider the merits of the different systems of organization of railroads, and to recommend an ideal organization, while it is the function of the Committee on Records, Reports and Accounts to simply recognize such organizations as exist without expressing any opinion as to their merits and advantages.

The nature of railroads, their strength, amount of trackage, number of constituent corporations which may form the larger corporation, location of the line geographically in our country, the limitations of State laws, and many other considerations make it necessary to organize bridge departments in America in various ways, each railroad preferring such an organization as may best suit its peculiar conditions and requirements; but in general it can be stated with exactness that the relations existing between the several sub-departments of the general Bridge Department are as contained in the outline organization herewith:

ORGANIZATION OF A WORKING BRIDGE DEPARTMENT.

Foreman of Bridges or Foreman of Carpenters	In charge of a working gang.
Master Carpenter or General Foreman of Bridges and Buildings or Supervisor of Bridges and Buildings or Superintendent of Bridges and Buildings	In charge of the several working gangs and supplies of material connected with one Division or District.
Division Engineer or Assistant Engineer or Engineer Maintenance-of-Way	In general charge of Engineering and Maintenance-of-Way work on one Division or District.

DEPARTMENT SYSTEM.	DIVISION SYSTEM.
Engineer Maintenance-of-Way or Chief Engineer.	Division Superintendent. General Superintendent. Engineer Maintenance-of-Way or Chief Engineer.

NOTE.—In some cases the different reports before reaching the Chief Engineer pass through the hands of the Bridge Engineer, Principal Assistant Engineer, or General Superintendent.

For the purpose of identification and briefness in discussing the nature, purpose and headings of the various blanks included in this

report, the duties of the principal officers mentioned in the various groups of the above outline will be referred to under the titles:

(1) Foreman of Bridges.
(2) Master Carpenter.
(3) Division Engineer.
(4) Chief Engineer.

The shortest titles have been selected by the Committee for use in the report, it being understood that the Committee does not intend to express any preference in this matter.

Having arrived at a conclusion as to what constitutes Records, Reports and Accounts, and having outlined an organization to explain the course of the various reports relating to bridges made from day to day and month to month in their passage from the man who originates the same to the man who places the same on file, the next question that naturally arises in connection with blanks is, What forms are necessary?

Each railroad will decide this question for its own satisfaction, but the Committee, after a careful study of the whole question, recommends that the number of forms should be as few as possible, including only such as are absolutely necessary to convey to the higher officers such information as is necessary for the proper and economical management of the railroad.

As a general proposition it may be stated that too many blank forms are in use, and much information is required from time to time that leads to no adequate result. Useless reports not only worry the Foreman of Bridges and other officers, but involve the expenditure of funds without accomplishing any result.

The question when and how often reports should be required will have to be decided by each individual railroad. The Committee recommends in this connection that the general principle to be followed is to require reports so often and at such a time as will bring before the general officers such data as are necessary to guide them in making decisions as to whether the road is being operated in a safe and economical manner, and to determine what improvements are necessary and desirable.

Another question which naturally arises is, How shall reports be made?

The Committee recommends in general that the amount of clerical work be reduced as far as possible by passing original reports up to the office in which the general records are compiled.

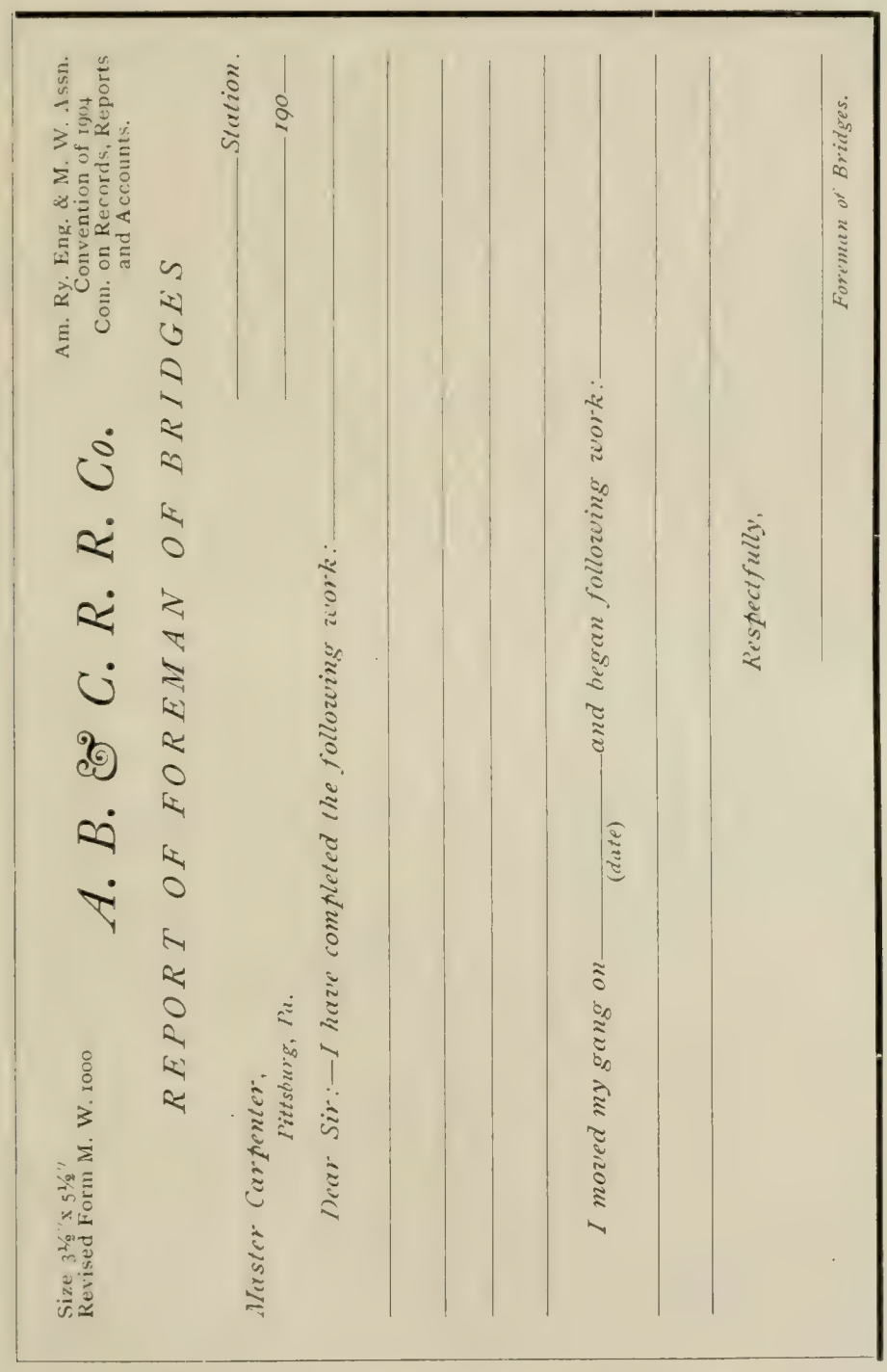
Certain blanks used in the Bridge Department, such as those for reporting the time of carpenters and other employés, are also used in the Track Department, and the Committee recommends that the Bridge Department forms for reporting material and tools conform in their general arrangement as to size to the similar blanks used in the Track Department.

In designing forms the general principle should be followed to make a blank as universally applicable as possible, limiting as few blanks as possible to the particular requirements of a single sub-department.

This subject is worthy of the most careful and minute investigation

and study to the end that the fewest blanks be used, the smallest amount of information consistent with good management required, the least amount of clerical work and the smallest expense incident to the cost of both labor and stationery.

The various reports which are handled by the different officers of



Size 3½" x 5½"
Revised Form M. W. 1000

A. B. & C. R. R. Co.

Am. Ry. Eng. & M. W. Assn.
Convention of 1904
Com. on Records, Reports
and Accounts.

REPORT OF FOREMAN OF BRIDGES

_____ *Station.*

_____ *190*

Master Carpenter,
Pittsburg, Pa.

Dear Sir:—I have completed the following work: _____

I moved my gang on _____ *(date)* _____ *and began following work:* _____

Respectfully,

_____
Foreman of Bridges.

SPECIFICATIONS FOR FORM M. W. 1000.

Form as here shown. Size 3½x5½ inches. To be printed on heavy manila paper. On address side, address of Master Carpenter to be printed.

the Bridge Department would be in general as follows, beginning with the reports made by the lowest officer, followed in regular order by the reports submitted to superior officers.

The Committee has thought it proper to treat the course of the various reports from the lowest to the highest, rather than from the highest to the lowest, keeping in mind, however, that the various reports should show the information wanted by the Auditor, the Chief Engineer, or the Division Engineer.

REPORTS MADE BY FOREMAN OF BRIDGES.

a. Daily Report of Foreman of Bridges.

Such a report would be 3½x5½ inches in size.

The blank should be made of heavy paper, so that it would not be necessary to enclose the same in an envelope, thus reducing the cost for stationery.

On the address side of the blank would be found the address of the Master Carpenter, to whom the daily report should be forwarded at the close of each day's work.

On the reverse side of the blank would be given information showing work done, where the gang would work the following day, the number of men on duty and the total number of hours worked, this information being necessary in order to keep the Master Carpenter informed as to the location of his men and what progress was being made in connection with the work in hand.

The Committee recommends such a blank: Form M. W. 1000.

b. Labor Report.

The Foreman of Bridges will report at the end of each month the time of the men in his gang in accordance with any general system of reporting time which is followed in all the sub-departments of a Maintenance-of-Way Department.

The Committee believes that it is unnecessary to specify any form to be used in the Bridge Department, as this subject was fully considered by the Committee last year in connection with its report on the proper method of reporting time of men in the Track, Bridge and Building, Signal and other sub-departments.

In the annual Proceedings of the Association in the year 1902, page 382, under the head of Labor Reports, will be found a recommended time book, which should be used by all employés in the Track, Bridge and Building, or Signal Departments.

The general system of handling labor reports mentioned on page 388, of the same report, is considered as applicable to the necessities of a Bridge Department as well as a Track Department, and the former recommendation of the Committee with regard to this matter is renewed at this time.

c. Monthly Bridge Material Report.

The Committee recommends that a special blank is necessary in the Bridge Department for reporting material on hand, received and used,

Size 8″x13″

Revised Form M. W. 1001.

Am. Ry. Eng. & M. W. Assn.
Convention of 1904.
Com. on Records, Reports and Accounts.

A. B. & C. R. R. Co.

_____ Division

MONTHLY BRIDGE MATERIAL REPORT

_____ Month of _____ 190

(Gang or District.)

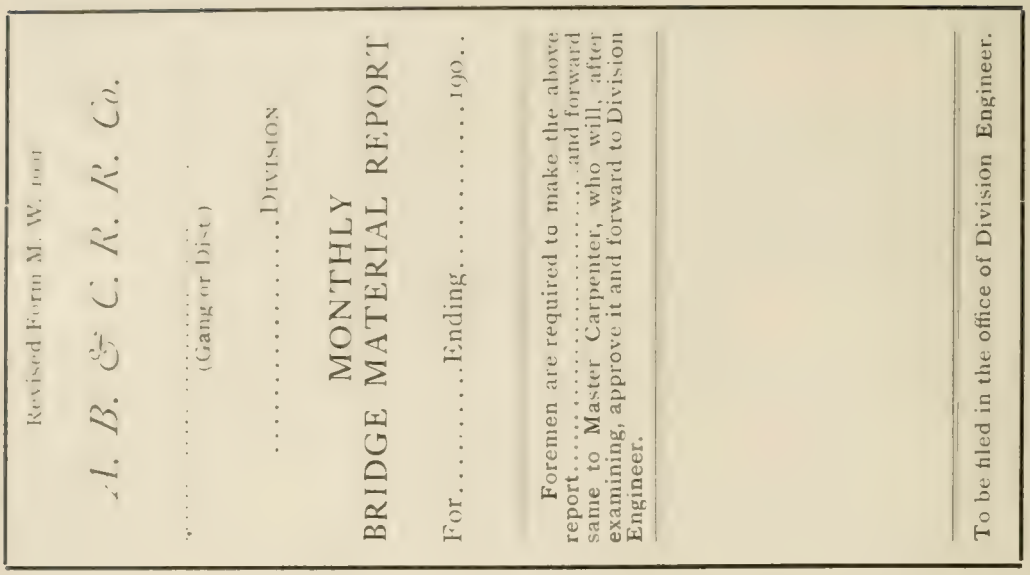
KIND OF MATERIAL	UNIT	ON HAND FIRST OF MONTH	RECEIVED	DISPOSED OF		ON HAND END OF MONTH	REMARKS
				USED	SHIPPED AWAY		
2.″0	0.″5	0.″7	0.″7	0.″7	0.″7	0.″7	2.″0

THREE SPACES PER INCH

The above statement is correct;

_____
Foreman of Bridges.

Correct; _____
Master Carpenter


Revised Form M. W. 1001

A. B. & C. R. R. Co.

.....
(Gang or Dist.)

.....Division

MONTHLY
BRIDGE MATERIAL REPORT

For.....Ending.....190..

Foremen are required to make the above report.....and forward same to Master Carpenter, who will, after examining, approve it and forward to Division Engineer.

To be filed in the office of Division Engineer.

SPECIFICATIONS FOR FORM M. W. 1001.

Form as here shown. Size 8x13 inches. Vertical lines, red; horizontal lines, blue.

because it is thought impracticable to design one blank which is adapted to the requirements of both the track and bridge departments.

The Committee recommends for adoption a monthly bridge material report blank, illustrated herewith, marked M. W. 1001. Such a blank shows all the information desired, viz., material on hand at the first of the month, material received, material used, material on hand at end of month, and material shipped away.

A column for "Remarks" has been provided in order that the Foreman of Bridges may designate where material was shipped or give any other information which may be necessary to fully explain the report.

The first column, headed "Kind of Material," may be filled in by each individual railroad to suit its own requirements. The size of this blank is 8x13 inches, which is the standard size adopted by the Committee for tool, structure, monthly material and inspection reports. The vertical ruling of the blank is in thirds of an inch, a spacing which allows the blank to be used on a typewriting machine, and at the same time gives a large space for the use of the Foreman of Bridges in entering his record.

It was thought best by the Committee to leave the monthly material report blank as proposed without any printed side headings in the column "Kind of Material," as the items might vary greatly on the different roads and at different localities, according to the ruling supply of material in each section of the country and the prevailing classes of structures, but each railroad company, in issuing the blank, could have suitable side headings for the principal classes of materials in use on their system printed on the blank, with blank spaces for sundry materials.

Some railroads prefer to combine tool report, job report and monthly distribution in one book. This can be done conveniently, and the practice

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Convention of 1904.
Com. on Records, Reports and
Accounts.

A. B. & C. RAILROAD COMPANY

_____

(Gang or District.)

_____ Division.

FOREMAN'S DIARY.

BRIDGE DEPARTMENT.

Month of _____ 190__

_____

Foreman of Bridges.

I certify that I have examined the within account of Material used on each job, and find it correct.

_____

Master Carpenter.

INSTRUCTIONS TO FOREMEN.

This Diary to be kept by Foreman of Bridges and sent to Master Carpenter and by latter sent to Division Engineer.

In entering in this Diary material used on different jobs you will be governed by the following rules, namely:

Enter the location, name and description of job by giving No. of each bridge or culvert in the column provided for that purpose.

Enter No. or size and name of articles used on each job in proper column, stating quantity, old or new; in case of lumber, give kind (oak, white or yellow pine, etc.).

Always show whether work is complete or not complete in column provided for that purpose. Job should not be noted as "Complete" before all labor as well as material is expended. If a job is complete with labor and without material, Diary should show the job and opposite it notation should be made "No material."

Material must be reported by the correct name.

Columns headed "Charge," "Price" and "Amount" should not be used by mechanics, but should be filled out in Div. Engineer's office.

This book can be sent forward promptly at the end of each month.

Show where material was taken from—Stock or Storehouse. If from Storehouse, give name of same.

Enter weight or measure of articles used on the job in columns headed "Quantity," as follows:

ACCOUNT OF MATERIAL

During the month of.....190

Date.	LOCATION, NAME AND DESCRIPTION OF WORK	Completed or not Completed	CHARGE		CR.
			Acct. No.	District	Class No.
3/4"	2 3/4"	9/16"	1/4"	7/16"	3/8"

THREE SPACES PER INCH

USED ON EACH JOB

By ..... Foreman of Bridges.

MATERIAL						
Number Articles	DESCRIPTION	Size	Quantity	Price	Amount	
← 11/16" →	← 1 7/8" →	← 3/4" →	← 9/16" →	← 3/8" →	← 7/16" →	← 7/16" →

is in use on a number of railroads in this country. The Committee believes, however, that it is best to have a separate blank for making a running report each month of materials; furthermore, where separate blanks are used, the reports may be forwarded at different times in the month, which frequently results in permitting the office forces to carry on their work in a more regular and systematic manner.

The aim of every designer of blanks should be to outline the same in a manner to obtain, with the least amount of work on the part of the Foreman of Bridges, the desired information, and in this connection the Committee desires to renew the observation made in its 1902 report that "inaccurate reports are worthless; records and accounts involve an extravagant use of the company's funds."

d. Foreman's Diary—Bridge Department.

A sample diary for the Bridge Foreman, marked M. W. 1002, is illustrated full size herewith, to be issued in book form. Size of pages, 5¼x8 inches; size of book, 5½x8½ inches.

The foreman's diary would be used daily by the Foreman of Bridges in entering a record of material used on each job, and it is probably much better for the Bridge Foreman to have a book like the one illustrated, in which he makes proper entries, rather than a separate blank. The diary would be forwarded monthly to headquarters. The diary should be forwarded at the close of the month to the Master Carpenter, who in turn, after approving the same, would send it to the office of the Division Engineer.

The information in the book should be compiled and the costs ascertained and entered by the Division Engineer's clerks for use in charging out expenses and checking material reports. The Bridge Foreman simply tallies his material and keeps a running monthly account in his "Foreman's Diary."

e. Bridge Department Tool Report.

It is the opinion of the Committee that a special blank for reporting tools is necessary for a Bridge Department, as the Track Department tool report blank cannot be adapted conveniently to cover the requirements of a Bridge Department.

Such a blank, marked M. W. 1003, has been prepared by the Committee and is illustrated herewith.

The size of the sheet is 8x13 inches, but it may conveniently be expanded by additional columns so as to make it 16x13 inches. The larger blank will not be required except where a very large number of tools are carried in stock.

The Committee has not thought it desirable to specify the printed list of items of tools to be entered on the blank, as each company can do this best according to the prevailing classes of tools used, and at the same time leaving blank spaces for sundry odds and ends.

f. Special reports.

The Foreman of Bridges makes such special reports as may be prescribed by the general rules of the railroad, these reports relating to

personal injuries, accidents, train detention, discharge tickets, etc., the reports being made on such uniform blanks as are used by the several departments of the railroad.

The Committee believes that the above enumerated reports are the only ones which the Foreman of Bridges should be asked to make.

On some railroads, however, there is in use a special form to be used by the Foreman for requesting material to be used on certain jobs of work. The practice of other roads is for the gang foreman to request such material by letter or by a clip note. In the opinion of the Committee, it is not necessary to include this with the recommended reports to be made by the Foreman of Bridges.

Railroads having large organizations, including masonry gangs, pile-driving gangs and special gangs engaged on various classes of work pertaining to bridges, will find it convenient to have the Foreman of Masons or Foreman of other special gangs use the same forms as the Foreman of Bridges in making reports as to material, tools, progress of work and in giving other information.

REPORTS MADE BY THE MASTER CARPENTER.

a. Reports.

Following the recommendation of the Committee, as contained in its annual report made to the Association in March, 1902 (see page 388 of the Proceedings), the Committee believes that the clerical work of the Master Carpenter's office should be reduced to a minimum, and this recommendation has been constantly kept in mind during the preparation of this report.

Labor, material, tool and special reports made by the Foreman of Bridges and forwarded by him to the Master Carpenter at stated times during the month, according to the system of handling records, reports and accounts, recommended by the Committee, should be carefully examined, checked and approved by the Master Carpenter.

These reports would subsequently be forwarded by the Master Carpenter to the Division Engineer, whose office should be supplied with such clerical assistance as would be necessary to properly prepare all payrolls, material reports, structure reports and such statements of accounts as should be forwarded to the superior and general officers.

This system of handling the business of the office of the Master Carpenter has received the general approval of the Committee.

b. Records.

In considering the subject of records to be kept by the Master Carpenter, the Committee is of the opinion that it is expedient and advantageous and economical in results to locate the Division Engineer and Master Carpenter at the same point along the line of the railroad, their offices being, as far as circumstances will permit, in the same building.

Where such an arrangement is followed, all records necessary for the proper information of the various officers of a road would be deposited and kept on file in the office of the Division Engineer, thus making it

Size 8" x13

Revised Form M. W. 1003.

Am. Ry. Eng. & M. W. Assn.
Convention of 1904.
Com. on Records, Reports and Accounts.

A. B. & C. R. R. Co.

BRIDGE DEPARTMENT TOOL REPORT

(Gang or District.)

DIVISION. For _____ ending _____ 190

TOOLS	ON HAND 1ST	RECEIVED	SENT TO SHOP FOR REPAIRS	BROKEN OR WORN OUT	ON HAND	TOOLS	ON HAND 1ST	RECEIVED	SENT TO SHOP FOR REPAIRS	BROKEN OR WORN OUT	ON HAND
1."5	0."5	0."5	0."5	0."5	0."5	1."5	0."5	0."5	0."5	0."5	0."5

THREE SPACES PER INCH

The above statement is correct:

Foreman of Bridges.

Correct:

Master Carpenter

Revised Form M. W. 1003

A. B. & C. R. R. Co.

.....
(Gang or Dist.)

..... Division

BRIDGE DEPARTMENT TOOL REPORT

For.....Ending.....190..

Foremen are required to make the above report.....and forward same to Master Carpenter, who will, after examining, approve it and forward to Division Engineer.

To be filed in the office of Division Engineer.

SPECIFICATIONS FOR FORM M. W. 1003.

Form as here shown. Size 8x13 inches. Vertical ruling, red; horizontal ruling, blue.

unnecessary for the Master Carpenter to keep any other records than such summaries and totals as might be required for ready reference.

The idea of the Committee is that when reports have once originated with the Foreman of Bridges and passed to his superior officer, they should be examined by the Master Carpenter and finally deposited in the office of the Division Engineer, where they would be available for examination at all times by all interested parties.

However, it is a fact recognized by the Committee that on many railroads the office of the Master Carpenter is located at a point distant from that of the Division Engineer, and where the two officers are thus separated the Committee suggests that the Master Carpenter should keep the following records in his office:

(1) List of employés; their addresses, positions, wages, date of employment and date of discharge.

(2) Number of men and total amount of money on each payroll of the several Foremen of Bridges.

(3) Copy of monthly bridge material report of Foremen of Bridges.

(4) Copy of Bridge Department tool report of Foremen of Bridges.

(5) Brief tabular memoranda of special reports submitted by Foremen of Bridges.

(6) Daily reports of Foremen of Bridges.

c. Requisitions.

The only report originated by the Master Carpenter under the system of handling business above outlined is requisition for material. The Committee recommends that the requisition blank in general use in all the different departments of a railroad be used by the Master Carpen-

ter, and no special blank is, therefore, required for the Bridge Department.

Attention is called to the system in effect on some railroads under which requisitions for material are originated in the office of Division Engineer after the Master Carpenter has advised his superior officer by letter as to what material is needed; however, it is probable that the best results are obtained under a system which permits the Master Carpenter to originate all requisitions for materials.

REPORTS MADE BY THE DIVISION ENGINEER.

The nature, extent and character of work done in a Division Engineer's office is dependent on special conditions and the system of organization in effect on the railroad, whether the work is carried on under the division or department system.

Where the former system is in use, the Division Engineer is at times given a very small clerical force, and the greater part of the work pertaining to records, reports and accounts is done in the office of the Division Superintendent.

However, the Committee believes that the expense incident to accounting is the same under either system, and it is recommended, in order to get the best results, that all necessary work in connection with records, reports and accounts should be done in the office of the Division Engineer, and such an adequate force of clerks should be assigned to his office as may be found necessary to properly and expeditiously carry on the work.

Where all clerical work incident to maintenance-of-way and structures is done, as recommended, in the office of the Division Engineer, the following reports, after being forwarded through the various channels, should be filed in the office of Division Engineer:

a. Labor reports of Foremen of Bridges.
b. Monthly bridge material reports of Foremen of Bridges.
c. Foreman's Diary—Bridge Department.
d. Bridge Department tool reports of Foremen of Bridges.
e. All special reports of Foremen of Bridges, except such original reports of a special nature as are passed on to the higher officers by the Division Engineer. Copies of these reports should be retained in his office for record.
f. Requisitions for material made by Master Carpenter.

The Division Engineer would originate certain reports specified below, using in all cases those standard blanks which are in general use in all departments of a railroad, excepting where otherwise specified:

a. Payrolls.
b. Discharge certificates.
c. Board bills.
d. Comparative statements of payrolls.
e. A summary of the monthly material reports made by the different Foremen of Bridges. At stated times annual or quarterly state-

ments would be prepared showing stock of material on hand on the entire division.

f. Statements showing distribution of labor or material among the several classifications of accounts for the information of the Accounting Department.

g. Either quarterly or annually a summary of all tools on the division to be forwarded to his superior officer, using the same blank for reporting tools as the Foreman of Bridges, making such changes in the heading of the blank as would adapt it to this particular purpose. The Committee thinks that no special blank is necessary for the use of the Division Engineer in making this report, as the blank used by the Foreman of Bridges can be readily adapted to this purpose.

h. Requisitions for material should be prepared by the Division Engineer, using the standard blank prescribed for all departments of a railroad, and this requisition should be forwared to the proper superior officer.

i. The Division Engineer prepares such reports and statements as are necessary for quarterly or annual summaries as to bridge work, and in so doing the usual special blanks would be used. In relation to the work of a Bridge Department, these statements should show the number of new bridges built during the year, old bridges renewed, lineal feet of trestle filled in, etc., etc.

j. Certain special reports made by the Foreman of Bridges and received by the Division Engineer through the Master Carpenter would be disposed of according to the general system of organization in effect on the railroad, some of these reports being filed in the office of the Division Engineer, while others would be passed on to a superior office.

k. Structure Report:

The Committee recommends to the Association for adoption a structure report blank, marked M. W. 1004—size 8x13 inches—which would be prepared by the clerical forces of the Division Engineer on the completion of a piece of work. This blank should show and embody all the items of expense incurred for material furnished and labor expended in connection with the particular piece of work covered by the report, such as a girder bridge, a truss bridge, a trestle, arch culvert, and many other structures which are built under the direction of the Bridge Department.

Such a report serves as a complete record of a structure and shows when work was started, when completed and other information valuable for record. Such a report would frequently be passed on to higher officers by the Division Engineer, or otherwise a summary of the data shown by the report would be forwarded to the final record office.

The Committee regards this blank as an essential one for the proper carrying on of the work of a Bridge Department.

The report is one of the most useful which is prepared by the Division Engineer, but attention is called to the necessity for accuracy

Size 8 × 11

Revised Form M. W. 1004.

Am. Ry. Eng. & M. W. Assn.
Conventoin of 1904.
Com. on Records, Reports and Accounts.

A. B. & C. R. R. Co.

_____ Division

STRUCTURE REPORT

The following material was used _____
(State Location of Structure definitely.)

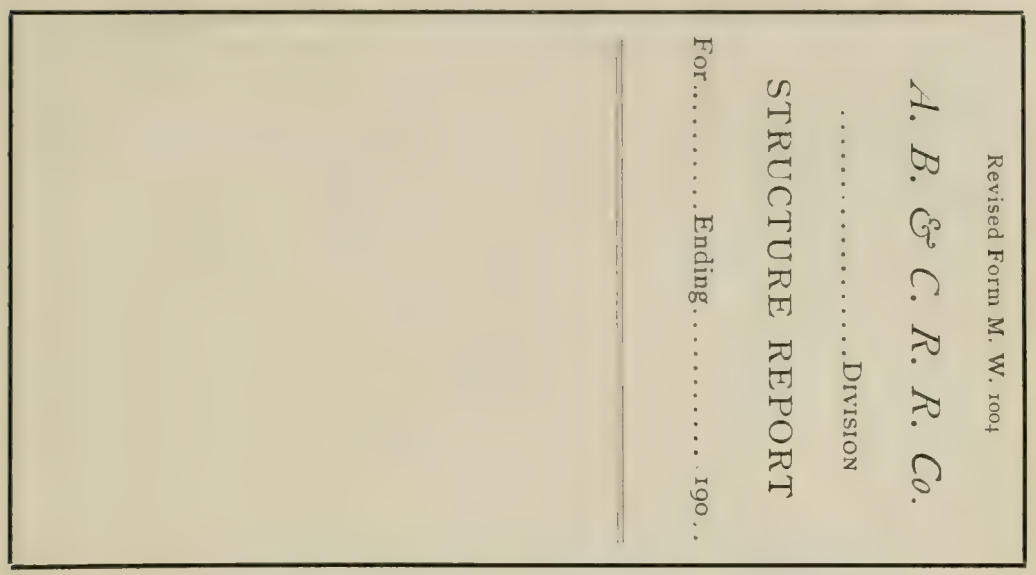
Work authorized _____ Commenced _____ Finished _____

KIND OF MATERIAL	UNIT	QUANTITY	PRICE	AMOUNT	
4.''2	0.''7	1.0	0.''5	0.''8	0.''8
KIND OF LABOR	HOURS				
OTHER CHARGES					

THREE SPACES PER INCH

The above statement is correct:

_____
Division Engr.



SPECIFICATIONS FOR FORM M. W. 1004.

Form as here shown. Size 8x13 inches. Vertical ruling, red; horizontal ruling, blue.

and completeness in connection with this report, as otherwise the results given will be entirely misleading, and hence worthless.

This blank really forms the basis of

LEDGER ACCOUNTS.

The general subject of accounts should not be overlooked in the preparation of blank forms, and yet the Committee at this time recommends no special blanks to be used in making up bridge accounts, because all such accounts are kept in accordance with the general system and on such general forms as are prescribed by the Accounting Department. Special blanks are not necessary, and, therefore, none are recommended.

It is recognized, however, that the Division Engineer will wish more detail information than is given to the Accounting Department, for the reason that he has to keep track of the cost of the work and equip himself to furnish estimates and cost for future work, consequently he must require his subordinates to furnish him information more in detail, but this information should be expanded from that required for the higher officers.

Again, the Chief Engineer's office will desire additional information not required by the Accounting Department in the way of records, and the reports of the Foremen and the Master Carpenter must always be designed to furnish the information desired by these higher officers without multiplying the number of the reports or making unnecessary work.

Recognizing that the Committee is under the necessity of framing blanks that would be generally useful for the entire list of railroads in the country, a middle course has been adopted with reference to the general subject of ledger accounts with individual structures.

The views of the different railroads are at variance on the general subject of ledger accounts kept in the office of the Division Engineer, and the Committee, without making a recommendation, is of the opinion that such accounts, when consistently and carefully carried on for a long period of years, become valuable for reference and use in many ways; but such accounts are not absolutely necessary, and, therefore, not included in the recommendations of the Committee.

The value of a ledger account with each bridge or structure is fully appreciated, because it is practically the only account which gives the Division Engineer the detail cost of important bridge work, and it is considered very important for the Division Engineer to make himself thoroughly familiar with the detail cost of his various pieces of bridge work so that he will be able to make careful estimates for new work.

What may be the comparative value of ledger accounts with individual bridges is not known by the Committee, but there is a class of engineers which takes the position that such accounts are not worth what they cost unless in connection with some structure whose maintenance is a joint affair.

The same class of engineers believes that too much distribution of accounts is needless and causes a serious addition to the clerical expense.

The radical defect in all such accounts seems to be the general lack of accuracy, this weakness in the accounts being due to the failure of railroad companies to expend enough money for clerical assistance to produce an accurate system of accounts.

Where ledger accounts are kept they should show the various items of labor expended and material used in connection with the maintenance of a particular bridge, and such a ledger would be kept in the office of the Division Engineer. There being no agreement among Maintenance Engineers regarding the value of ledger accounts, the Committee feels justified in taking the position that the cost of annual maintenance for each individual structure is desirable and will prove valuable information if accurately and continuously kept for a long term of years, but does not think such information is absolutely essential, and, therefore, no special blank or form for the purpose is recommended for adoption.

The general subject of unit costs of construction and maintenance work is worthy of very careful study, because any deduction drawn, if accurate, will prove very valuable to the engineer.

Unit costs of work are essential in any estimate according to which statements and appropriations must be made before work can be undertaken, as the unit cost of executed work under conditions known to the general officers is practically the one basis on which a corrected estimate can be made.

BRIDGE INSPECTION REPORT BLANKS.

The general subject of inspection of bridges is one of vital importance to every railroad, but a casual study of the subject indicates that the greatest diversity of methods and systems of inspection prevails on differ-

ent railroads as to the frequency and methods of making inspections and the forms used to report and record the results.

The Committee considers that the subject of Bridge Inspection Forms refers to the inspection of bridges on a road by the regular Maintenance Department and not to Engineering Inspection during construction.

It is not within the province of this Committee to make recommendations as regards the inspection rules and methods, but some method or distinguishing characteristics of bridge inspection systems must be recognized as the basis of the discussion and forms to be recommended by the Committee.

The Committee desires to emphasize particularly that the forms it recommends can be filled out by anyone making the actual inspection or compiling the results for transmission to higher officers, and that the headings could be changed accordingly, if desired.

For the purposes of this report, bridge inspection will be classed in two groups, viz., "Current Inspection" and "General Inspection."

Current Inspection is the class of inspection carried on by the men in direct charge of the maintenance of bridges and trestles on a division or district, usually made by a special Bridge Inspector or by Bridge Foremen, or Master Carpenter, right along at all times or periodically on special monthly, bi-monthly or quarterly trips.

General Inspection covers the annual, or in some cases semi-annual, inspection of all bridges, trestles and openings of a railroad by the Bridge Engineer, or some representative of the Chief Engineer or Engineer of Maintenance of Way, and has for its object not only to check the work of the Division Organization, but also to make suitable record of the general conditions of the bridges on the line, and further to ascertain and settle what work has to be done in the following working season.

The special Bridge Inspection Reports required for the "Current Inspection" are:—

a. Daily Bridge Inspection Report made by a regular Division Bridge Inspector, Foreman of Bridges, Gang Foreman or Master Carpenter. The purpose of this report is to record the condition of the bridge and the fact that it had been inspected on a certain date, and further to call attention to any minor current repairs required either in the near future or emergency repairs calling for immediate action. This form should be made out while at the bridge and mailed promptly to the immediate superior office. For the purpose of this Committee report it will be referred to as the "Bridge Inspector's Daily Report," and assumed that it is mailed to the Master Carpenter, who in turn forwards it to the Division Engineer.

In the opinion of the Committee this report should be a simple, small blank, without special column or side headings, allowing the Inspector (usually a practical bridge mechanic) in filling it out to use his own phraseology and thus making it elastic and adaptable to all classes of bridges, trestles, track openings and structures for which such reports are prescribed. The blank can be either in pad form or book form. It should be small and of pocket size. The Inspector would either write out a copy

Size 5¼ x8

Revised Form M. W. 1005.

Am. Ry. Eng. & M. W. Assn.
Convention of 1904.
Com. on Records, Reports and Accounts.

Report No.

A. B. & C. R. R. Division

CURRENT BRIDGE INSPECTION REPORT

I have to-day inspected

at

and find its condition as follows:

The following work is required to maintain structure in good condition:

The following work must be done to keep the structure safe:

Inspector.

Date,————————————190

NOTE.—Make separate report for each bridge or structure inspected. Send report to the————————of the Division. Report by telegraph to the————————and the Superintendent of the Division all serious defects that require attention.

SPECIFICATIONS FOR FORM M. W. 1005.
Form as here shown. Size 5¼x8 inches. All letters black.

for his record or use a carbon paper and retain the duplicate. On some roads the book is made up with a stub. Instructions to Bridge Inspectors are issued by circulars printed in each book. The Inspector notes on the report any material needed for necessary repairs and also furnishes a sketch and dimensions of any special parts required.

The Committee recommends the adoption of a form to be known as "Bridge Inspector's Daily Report"—marked M. W. 1005—to be issued as a separate sheet, size 5¼x8 inches, making a book 5½x8½ inches, if desired to have it bound in book form. The horizontal ruling should be spaced ⅓ inch.

This form can be readily adapted and its size changed so as to be used in book form with a stub for the Bridge Inspector's Record. The Committee presents this blank as a separate small sheet, leaving it to individual preferences to issue it in book form, with or without stub, but expresses the opinion that the small sheets in pad form are preferable.

b. Monthly Bridge Inspection Report, either as the result of a special inspection trip made monthly by the Division Engineer, Master Carpenter, or Superintendent of Bridges and Buildings, or else compiled from the "Bridge Inspector's Daily Reports" at the end of each month. The purpose of this report is to summarize the daily inspections or trip inspections during the month and make record of same, transmitting copies to the Division Superintendent, Bridge Engineer, Engineer Maintenance of Way or Chief Engineer, according to the organization of the road. These reports contain columns for number or name of bridge location, date inspected, condition of structure, and in some cases memoranda are added, usually by the Division Engineer, giving recommendations or stating in minor matters what action has been taken (such as "repairs made," "materials ordered," "repairs will be made next month," etc.). For the purposes of this Committee report this form will be referred to as the "Monthly Bridge Inspection Report," and assumed to be prepared in the Division Engineer's office.

In the opinion of the Committee this report should be simple and without numerous special column or side headings—in other words, be adapted to serve as a summary for the "Bridge Inspector's Daily Reports," with an additional column to be filled out by the Division Engineer or his representative in charge of this work as to recommendations or action taken. In case the railroad company does not adopt the daily report system, but has a monthly report system based upon special monthly inspections, then the same "Monthly Bridge Inspection Report" (possibly with slight modifications of the heading) would serve as a brief inspection report, to be filled out at each bridge and subsequently neatly copied in the office and forwarded as the Monthly Inspection Report of the division.

In this case some roads issue these blanks in book form of a handy size for field use, and also have special larger, separate sheets, with similar ruling, for preparing report to be sent to the superior office.

The Committee recommends the adoption of a form to be known as "Monthly Bridge Inspection Report"—marked M. W. 1006—to be issued as a separate sheet, 8x13 inches. The horizontal ruling should be ⅓ inch. In

Size 8 x 13 Revised Form M. W. 1906. Am. Ry. Eng. & M. W. Assn. Convention of 1904 Com. on Records, Reports and Accounts.

A. B. & C. R. R. _____ Division.

SUMMARY CURRENT BRIDGE INSPECTION REPORT

For _____ 190

Bridge No. or Structure	Kind of Structure	Day of Month Insp'td	Condition	Action taken or Recommendation

Date_____ 190 _____

NOTE – This report to include all bridges and structures inspected during the period covered by the report.

Revised Form M. W. 1006

A. B. & C. R. R. Co.

.....Division

SUMMARY CURRENT

BRIDGE INSPECTION REPORT

For.....Ending.....190..

Foremen are required to make the above report.....and forward same to Master Carpenter, who will, after examining, approve it and forward to Division Engineer.

To be filed in the office of Division Engineer.

SPECIFICATIONS FOR FORM M. W. 1006.

Form as here shown. Size 8x13 inches. Vertical ruling, red; horizontal ruling, blue.

case the reports are to be typewritten, horizontal ruling should be omitted. Where this report is to be used in the field for recording the inspection while on the ground, it can be issued in book form and the size of the sheet reduced or made to cover two pages facing each other. The Committee presents this blank as a separate sheet of approximately legal cap size, leaving it to each railroad to issue same in modified shape in book form, provided it is to be used in the field. In case, however, the system of "Bridge Inspector's Daily Reports" is adopted, as recommended by the Committee, then the "Monthly Bridge Inspection Report" becomes an office blank, and hence should be properly in sheet form.

The two reports recommended by the Committee, viz.: the "Bridge Inspector's Daily Report" and the "Monthly Bridge Inspection Report," are all the inspection reports needed, in the opinion of your Committee, to cover the regular routine "Current Inspection," serving mainly to keep the bridge safe as far as ordinary maintenance by the division force is concerned and at the same time enabling the superior officers to be advised of what is being done.

c. The General Inspection is made yearly, although in some cases semi-yearly or quarterly, usually by a representative of the Chief Engineer or Engineer Maintenance of Way, such as the Bridge Engineer, General Bridge Inspector, or Assistant Engineer, who passes over each division of the road in connection with the division men and makes a general inspection of all structures on the road. This inspection serves not only to check up the work of each division, but also makes a comparison between the various divisions possible and promotes uniformity in the standard of maintenance and methods. It has also an important element in serving to establish what structures should receive extensive repairs or be renewed or replaced, the decision usually resting with the Chief Engineer or one

of the higher officers. It also serves in many ways as a check on the general office bridge records, recording changes made in the existing structures, etc.

It is apparent, therefore, that there is warrant in this case for a very complete and full inspection report, going into greater detail on the report blank than necessary for the routine current maintenance work.

A great many roads of the country have very elaborate and detail inspection reports for this purpose, some in sheets as large as four square feet in size, others in sheets of usual legal cap size, others in small or large book form, others in large books or sheets, one-half of each sheet being virtually a copy of the "Bridge Record Book," and finally the method of using individual blank books for field memoranda (using the "Bridge Record Book" or blue prints of the "Office Bridge Records" for reference as to information about the bridge) and subsequently in the office compiling the information on large inspection reports.

Most of the forms specify in great detail, by vertical column or side headings, the various items to be investigated at each bridge, in some cases as high as fifty items. While on particular roads and under certain organization systems this method of minute detail in the inspection reports may be working successfully, the Committee does not believe that, in selecting a blank as adapted for general use by all railroads of the country, it should lose sight of the fact that there are many railroads that would not countenance this great detail, nor would they have the organization which would enable it to be carried through. To fill out these blanks conscientiously while on the ground would make the inspection cover too much time, and some roads which report such blanks as nominally standard do not rigidly carry out the system from year to year.

It is impossible to prescribe in a form headings and items to be examined which are all adapted to all classes of bridges, trestles, waterways, track openings, highway bridges, etc., and hence, in practice only part of the items can be filled in for any particular structure, and frequently special items have to be added for which usually too little space is allowed. It would seem preferable to issue instructions and rules for inspecting the various classes of structures, and leave it to the Inspector to apply these rules in each particular case, mentioning in the report the general conditions and noting specially where defects are found.

For the reasons indicated, especially also as the Committee's endorsement of a blank should be such as to allow of its adoption generally, the Committee believes that the General Inspection Report should be simple and elastic, so as to accommodate itself to any class of organization on a road and be adapted to the various classes of structures to be inspected without having to omit filling out many of the columns or having to add numerous items. In other words, the form should be more general, leaving it to the Inspecting Engineer to fill it out to such extent as thought desirable. Further, it should not be necessary to transcribe from the "Bridge Record Book" complete data as to the physical characteristics of the structure, as the transcribing of this data is unnecessary if

the Inspecting Engineer has a copy of the Bridge Record with him for reference. It is desirable, however, for ready reference, especially for the higher officers who are not familiar with the various types of structures, to note briefly the characteristics, such as kind of bridge, length, age, and any pertinent reference to previous reconstruction or recent work done. The main feature in such a form is not to have it circumscribed by too much specialization and minutiæ in the column or side headings, but to leave ample space and opportunity to vary the wording of the record in accord with the various conditions and classes of structures to be embraced in the one report. Such a report will allow all classes of memoranda to be made according to the exact scope and special purpose for which it is made.

The Committee recommends the adoption of a form to be known as "General Bridge Inspection Report," marked M. W. 1007, to be issued in book form and in separate sheets. In book form for field use each page would be 5½x8 inches, with sheets, 11x8 inches, folded in the middle, making a book 6x8½ inches. The separate sheets for office use and summary reports should be exactly the same as used in the book, viz., 11 inches wide and 8 inches high, printed on one side only. If desired, however, special blanks of larger size for office use could be printed. The horizontal ruling should be ⅓ inch. The separate sheets for office summary reports should be left without horizontal ruling if typewriter is to be used.

Summing up, the Committee recommends three special forms for Bridge Inspection by the regular Maintenance of Way forces, viz.:

a. Bridge Inspector's Daily Report—M. W. 1005.
b. Monthly Bridge Inspection Report—M. W. 1006.
c. General Bridge Inspection Report—M. W. 1007.

The Lehigh Valley Railroad uses a daily report similar to recommended type a.

The Lehigh Valley Railroad, Wabash Railroad, Lake Erie & Western Railroad, and Chicago & Northwestern Railway use a form similar to recommended type b.

The Great Northern Railway and the Norfolk & Western Railway use a book form similar to recommended type c. The Norfolk & Western has, in addition, a separate large form in separate sheets with similar headings and bridge data printed on left side, the inspection results and recommendations being filled in on right-hand side.

In addition, the Committee presents for the information of the Association the following forms, as illustrating typical forms not covered in the recommended forms—a, b and c.

EXHIBIT "A." Pere Marquette Railroad, Bridge Inspection Report, representative of type of individual sheet for each bridge inspected, with detail enumeration of items to be examined. The Boston & Maine Railroad uses a similar small report in book with stub. The Central Vermont Railway uses an individual report for each bridge on a large sheet, with a small number of side headings. The Southern Railway

Size 11" x 8"

Revised Form M. W. 1007.

A. B. & C. R. R.

GENERAL BRIDGE

_____Division

From_____ To_____ _____

Bridge No. or Structure	Location	Kind of Structure	Bridge Data	Date Inspected

SPECIFICATIONS FOR FORM M. W. 1007.

Form as here shown. Size of page, 5½x8 inches. To be issued in book form for field use, and on separate sheets for office use. Vertical ruling, red; horizontal, blue.

INSPECTION REPORT.

Am. Ry. Eng. & M. W. Assn.
Convention of 1904.
Com. on Records, Reports and Accounts.

For_____

Inspected by _____190

General Condition, Description of work required, Recommendations.

Exhibit A.

Am. Ry. Eng. & M. W. Assn.
Convention of 1904.
Com. on Records, Reports and Accounts.

PERE MARQUETTE R. R. CO.

BRIDGE INSPECTION REPORT.

Bridge No. ....., **Div.**

Inspected ..... **190**..

Surface .....

Alignment .....

Tie Guards .....

Tie Guard Bolts .....

Ties .....

Stringers .....

Stringer Bolts .....

Caps .....

Piles .....

Sand Plank .....

Sway Braces .....

Sway Brace Bolts .....

Posts, Frame Bents .....

Sills, " " .....

.....

Remarks: .....

.....

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.....

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.....

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.....

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.....

.....

(*Sign Here*)

.....

Perforated line for Stub

EXHIBIT "C."

Am. Ry. Eng. & M. W. Assn.

Convention of 1904.

Com. on Records, Reports and Accounts.

BRIDGE INSPECTION BLANK.

Sou. Pac. Co.

13. After a wooden bridge or trestle has been in use over three years, a close inspection must be made twice a year as to the condition of the timber, by boring holes in suspicious looking places, especially near the bridge seats and at the ends of stringers and braces. The nature of the boring will reveal the fact if the timber is solid or decaying. The boring, which should never exceed one-quarter inch in diameter, must be made under the personal supervision of the general bridge inspector or some other officer expert in work of this kind. Whenever splices exist, bolts in chords, and principally in long-span bridges where they generally occur in every panel, it is very important to examine them thoroughly and to note if they are pulling apart, which would indicate a weakness or a defective clamp. The braces and counter braces should always have a square and even bearing upon the angle blocks, and the sliding away from their true position, if any, would be sure evidence that the bridge needs immediate adjustment.

14. Tubs filled with water and buckets should be kept constantly on hand on every span of all wooden bridges unless otherwise protected against fire.

GENERAL CONDITIONS.

15. The action of a bridge under a passing train is the best practical test of its stability, and no inspection should be completed without having made such observation and without having carefully noted any undue deflection, swaying, or twisting of the bridge as a whole or of parts thereof.

16. The inspector must, with proper instruments and, if necessary, with the assistance of a civil engineer, measure carefully the absolute deflection and swaying of any bridge reported to him as doubtful, and if these movements are excessive, the fact must be reported to the proper division officer also to the Superintendent of Bridges and Buildings and the Engineer of Maintenance of Way.

17. The tracks on bridges, as well as on the approaches thereto, should always be in good line and surface; they should be firmly bedded on the approaches so as to avoid any undue shock when a train comes on a bridge at a high rate of speed.

Exhibit "C."

SOUTHERN PACIFIC COMPANY—MAINTENANCE-OF-WAY DEPARTMENT.

Condition of Bridges, Viaducts and Trestles on _____ *Division* _____ *Railroad* _____

Number	Kind of Bridge	Name of Stream or Cañon	Foundation		Bed Plates and Pedestals	Rockers and Frames	Trusses					Girders	Laterals		Floor System			Rivets	Hangers	Castings	Paint	Action Under Trains	Length of Structure Requiring Renewal Next Quarter	Date of Inspection	Remarks and Recommendations
			Masonry Piers	Wooden Piers or Bents			Upper Chord	Lower Chord	Posts and Bars	Rods and Braces	Counter Braces		Upper	Lower	Floor Beams	Stringers	Ties and Guard Timbers								

MAINTENANCE OF WAY
DEPARTMENT

CONDITION OF BRIDGES

Railroad

Division

19

CERTIFIED CORRECT

Inspector.

APPROVED

INSTRUCTIONS.

The blank [illegible] Bridge Engineer, Maintenance of Way or the Superintendent of Bridges and Buildings, the contractor for bridge inspection or other person who has been employed to report on the condition of the bridges and trestles on the Railroad, by the persons employed in Bridge and Building, Division or Superintendent of Division of respective lines of bridges [illegible]

EVERY LINE OF LETTERS AND FIGURES must be inserted opposite the structure and its condition reported on this blank. In case any defective structure requiring attention, or dangerous structure, a special report will be made by letter or telegram, and the inspector will do everything necessary to prevent accidents, promptly and without waiting for special orders.

The letter in [illegible] opposite the number of the structure indicates that the portions named at the head of the column are in good condition.

The letter R indicates that the structure is in bad condition

Read instructions, will be set down, under head of remarks and recommendations, and, if necessary, continued under the head of remarks on the back of the sheet.

Character of foundations, material for any repairs or construction previously reported to the inspector and which are to be made by the structure

Under kind of bridge state whether truss, trestle or viaduct, and whether of wood or iron.

DIRECTIONS GIVING THE MOST IMPORTANT POINTS TO BE OBSERVED WHILE INSPECTING BRIDGES.

MASONRY.

1. Every abutment, pier or wall must be carefully examined, especially such as have shown signs of yielding either by sinking or by tipping or bulging out from the perpendicular.
2. All loose, broken or defective stones in the face or backing must be noted. They must be set down in red ink and [illegible]
3. All open joints in the masonry, particularly at the top of the wall, must be noted. [illegible]

WOODEN PIERS AND TRESTLE BRIDGES.

4. All posts or piles that are found to be decayed, broken or otherwise defective must be closely examined to see if they [illegible] to more rapid deterioration.

IRON BRIDGES.

[illegible] bed plates, [illegible] the bed plates, [illegible] the pedestals, [illegible] the rollers should be kept free and clean. [illegible] and the [illegible] and [illegible] and [illegible] and

Exh

P

Bri

Ins

Sur

Ali

Tie

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Tie

Str

Str

Cap

Pil

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uses a single sheet for each bridge, folded, double letter paper size, enumerating 48 items to be answered.

EXHIBIT "B." Canadian Pacific Railway, Bridge Inspection Report, representative of type of reports with a large number of detail items enumerated in side headings, and with a number of vertical columns for various bridges, and then on the right, additional data as to any special item of any particular bridge. The same blank is reduced in size and spaced differently and issued in book form for field use. Similar blanks are in use in sheet form on the Wisconsin Central Railway.

EXHIBIT "C." Southern Pacific Railway, Report of Bridge Inspection, representative of type of large bridge report sheets, with a large number of detail items enumerated and grouped in vertical columns. This sample is typical of similar reports in use on the New York Central Railroad, Pennsylvania Lines West of Pittsburg, Toledo, St. Louis & Western Railroad, Buffalo, Rochester & Pittsburg Railroad, Cincinnati, New Orleans & Texas Pacific Railway.

BRIDGE OFFICE RECORDS.

The office of final record, whether that be Engineer Maintenance of Way, or Chief Engineer, depending on the organization of the particular railroad, should contain such records as will enable the nature, extent, condition, strength and cost of all bridges to be ascertained at all times.

Original plans of bridges showing exactly how the structure was built should be constantly on file. The information should be complete in every respect, and should show depth of foundation, character of material in the foundations, design of the superstructure, topography of the country adjacent to the bridge, and all other information necessary to the complete exhibit of the nature and character of the structure.

When it becomes necessary, by reason of the introduction of heavier motive power, to make alterations in bridges, the work should be carried out in accordance with complete plans produced by the Bridge Department. These drawings should be filed with the original plans, the filing clerk making such necessary cross-references in his card index system as will enable one to locate the desired drawing at once.

The office of final record should also keep such records, or statements, as will show the cost of original structures, but the Committee believes that no special blank is necessary for this purpose, and, therefore, none is recommended.

The following would seem to be the most important special blanks required:

a. Physical Characteristics:

It does not appear, from the information received by the Committee, that any special form of record is kept by the Bridge Departments of the several roads in this country to show what is commonly termed Physical Characteristics. Sub-reports are generally prepared only once a year, and the information is presented on a blank specially constructed for the occasion. Information necessary in order to prepare reports for

Exhibit "B" Form 921

Am. Ry. Eng. & M. W. Assn.
Convention of 1904.
Com. on Records, Reports and Accounts.

Canadian Pacific Railway.

BRIDGE INSPECTION REPORT.

.....*Division.* *From*..... *To*.....

Inspected by..... .....190....

	No.	No.	No.	No.	No.	Bridge No.	Item No.	REMARKS.
Class,								
Length,								
Number of Spans,								
Height,								
1. Waterway,								
2. Track and Approaches,								
3 Ties,								
4. Guard Rails,								
5. Caps and Stringers,								
6. Sills and Posts,								
7. Sway Braces,								
8. Piling,								
9. Masonry Piers,								
10. Bench and Wing Walls,								
11. Arch and Cover Stones,								
12. Paving and Riprap,								
13. Culvert Pipe,								
14. Timber Box,								
15. Bed Plates, Rollers, etc.,								
16. Wall Plates,								
17. Bolsters,								
18. Castings,								
19. Bottom Chord Joints,								
20. Packing Bolts,								
21. Keys and Clamps,								
22. Gib Plates,								
23. Covering,								
24. Stringers and Bearings,								
25. Floor Beams and Bearings,								
26. Tension Members,								
27. Bottom Chords,								
28. Compression Members,								
29. Lateral Connections,								
30. Hangers,								
31. Pins,								
32. Rivets								
33. Drain Holes and Details,								
34. Line and Chamber,								
35. Adjustment,								
36. Vibration,								
37. Deflection,								
38. Painting,								
39. Water Barrels and Ladders,								
40. Rubbish,								
41.								
42								
43.								
44.								
45.								

EXHIBIT "D."

Am. Ry. Eng. & M. W. Assn.

Convention of 1904.

Com. on Records, Reports and Accounts.

BRIDGE RECORD.

Exhibit D

A. B. & C. R. R. Co.

Maintenance-of-Way Department — Division.

Record of Amount and Character of Bridges, Trestles, Culverts and other Trans Structures.

19[illegible]

Months	Through Steel Bridges—Lineal Feet: Masonry Piers	Through Steel Bridges—Lineal Feet: Cylinder Piers	Through Steel Bridges—Lineal Feet: Treated Piers	Through Steel Bridges—Lineal Feet: Total Number	TRESTLING—LINEAL FEET: Standard: Untreated	TRESTLING—LINEAL FEET: Standard: Partly Treated	TRESTLING—LINEAL FEET: Standard: All Treated	TRESTLING—LINEAL FEET: Standard: Untreated	TRESTLING—LINEAL FEET: Standard: Partly Treated	TRESTLING—LINEAL FEET: Standard: All Treated	TRESTLING—LINEAL FEET: Ballast Deck	TRESTLING—LINEAL FEET: Total Number of Bents	TRESTLING—LINEAL FEET: Total Lineal Feet	CULVERTS—NUMBER: Wood: Treated	CULVERTS—NUMBER: Wood: Untreated	CULVERTS—NUMBER: Steel	CULVERTS—NUMBER: Masonry	CULVERTS—NUMBER: Stone	Wooden Bridges—Lineal Feet	Girder	TUNNELS		
July																							
August																							
September																							
October																							
November																							
December																							
January																							
February																							
March																							
April																							
May																							
June																							
TOTAL																							
Total [illegible]																							
[illegible]																							
REMARKS																							

Months	Wooden and Combination Bridges: Howe Trusses: No.	Howe Trusses: Lineal Feet	Stringer Spans: No. Spans	Stringer Spans: Lineal Feet	Combination: No. Spans	Combination: Lineal Feet	Lineal Feet	Highway Crossings: Number	Railroad Crossings: Number	Fences	Cattle Guards: Number	Number	Bridges Moved: Number	Additional	Ballasted	Piles
July																
August																
September																
October																
November																
December																
January																
February																
March																
April																
May																
June																
TOTAL																
Total [illegible]																
[illegible]																
REMARKS																

the Interstate Commerce Commission is worked up from time to time, and generally this information is the basis of those annual reports made regarding the physical characteristics of road.

The investigations of the Committee have not been sufficiently thorough as to convince the members that any special blank is required for reporting physical characteristics of bridges, and hence no blank is recommended. Each Division Engineer can readily and conveniently make up his own blank from year to year, the size and arrangement of the same being adapted to the peculiar conditions existing on a particular road.

The Committee, however, presents herewith for the information of the Association a blank marked Exhibit "D," size 16x21 inches, which embodies many of the necessary features of such a report with regard to bridges, trestles, culverts, viaducts, tunnels, highway crossings, railroad crossings, fences, cattleguards, ballasted track, sidings, alignment and profile.

Attention is called to the fact that the blank is not specially adapted to the Bridge Department, but includes information regarding both track and bridges, and hence is a general rather than a special blank. Keeping in mind that the present Committee is dealing solely with Bridge Department blanks, it has been decided not to recommend this blank, because it is not one specially for the use of the Bridge Department.

This blank marked Exhibit "D" is intended to be corrected monthly, so that the record would always be right up to date. An examination of the blank in detail will indicate at a glance just how the information is to be entered and kept.

b. Office Bridge Record Book:

The proper record of the physical characteristics of bridges, and their cost of construction and maintenance, are subjects that deserve the careful consideration of all railroad engineers; but, after examining the blanks furnished by a number of the representative railroads of this country, the Committee is convinced that the Bridge Departments are not giving this subject the attention it deserves; many of the so-called Bridge Records being only a partial list of the dimensions of the main members of the bridge, with the number and location of the structure and date of erection, together with some other minor information. Some roads go a little farther and record both the estimated cost and the actual cost.

The Committee is of the opinion that a Bridge Record, to be valuable, should be complete in every detail; first furnishing a complete description of the structure and all natural conditions surrounding it, that would, in any way, affect its stability or existence

The record should show the complete bill of material actually used in the structure, with all dimensions; it should show the Annual Inspection returns with date and name of Inspector; following this should be shown the cost of repairs and renewals authorized after the annual Inspection; then should be recorded the paint, with dates, kind of paint, number of coats and cost.

With the record kept in this manner, the office will have, on one sheet, all information necessary to be known of any structure, and accurate

figures on which to base estimates for similar structures or annual estimates.

The Committee herewith submits Exhibit "E"—size 16 inches by 21 inches, which is thought to embody many of the features necessary for a complete Bridge Record. Under the columns headed "Description" quite a number of items are enumerated which the Committee considers among the essentials, and quite a number of blank spaces are left to be filled in with information to suit special requirements.

The columns under the heads of "Bill of Material," "Inspection," "Cost of Repairs" and "Paint" are self-explanatory.

The bottom of the sheet should be cross-sectioned as shown, and on this portion a cross-section and elevation of the structure may be shown with any distances and dimensions that seem desirable, especially should the high water line, bottom of stream and direction of the various strata of earth, etc., be shown as ascertained by borings or pile driving records; the blank to be printed on one side of the sheet and bound in books (loose ledger form) so that the sheets can be easily removed for making sketches and for convenience in placing the records of new bridges in their proper order.

The specifications for Exhibit "E" are as follows:

Size of sheet, 16 inches by 21 inches.

Horizontal ruling—Color, green, spaced three-sixteenths inch.

Cross-section sheet lines—Color, green. One-inch squares divided in 10 smaller divisions.

All other lines spaced as shown on form and printed in red.

All letters black.

This blank should be printed on either tracing cloth or what is called bond paper, so that copies or prints could be readily made of each individual sheet. This feature is worthy of careful study, as the blank is intended to be bound in book form, so that copies of individual sheets could be made at any time.

Exhibit "E" does not show the name of the contractor or the year in which the structure was built, rebuilt, or lengthened, but this information should be shown on the blank.

The blank is intended to show briefly the history of the structure brought up to date, cost of the original structure, itemized cost of the completed structure, photographs of the old structure and the new, diagram giving depth of foundations, borings, nature of foundations, and, in fact, a brief monograph of the structure, such as is usually given in accounts of more important structures for publication. They are generally made in duplicate, bound in book form, and have a cover with a printed title. They are filed, one in the general office and one in the division office, so that at any time complete information concerning a given structure can be had, except mechanical details; such reference must be made to the detail drawings.

Keeping in view the present work of this Committee, viz.: the design of blanks specially adapted to Bridge Departments in general in all parts of this country, the Committee believes that an office bridge record book

is so valuable, necessary and essential as to make it desirable to give the subject longer study, to the end that a blank may be produced which will be more complete and more generally applicable than the one herewith shown as exhibit "E." The Committee does not recommend the same for adoption by the Association, for the reason above stated, viz., the belief that a more complete blank is required for the general use of roads which operate under the variable conditions which are found in the different parts of this country.

This same subject was considered by the Committee last year, and the members of the Association are referred to the descriptive matter on pages 361, 362, 363, 364, and 365 of Volume 3, Proceedings of the Third Annual Convention of the Association.

c. Trestle Record Book:

The Committee also presents one typical form of a trestle record—Exhibit "F"—which is probably not used in some parts of this country, and it has some good features; it may fulfill all the requirements of some of the smaller roads, but is not thought by the Committee to be as complete a record as is desirable, and is therefore not presented as a standard form.

The size of this blank is 8 inches by 13 inches, which is the standard size for many other blanks submitted by this Committee.

Exhibit "F" is made up for a trestle, but can readily be adapted to a bridge, viaduct, crossing or culvert. The blank would be used after the same manner as Exhibit "E," the loose sheets being bound in book form, so that they could readily be detached for the purpose of making copies or prints. This blank is not recommended by the Committee to the Association for adoption, because a trestle record book is not an essential blank adapted to the general uses of a Bridge Department.

Any complete office bridge record book, such as Exhibit "E," which is generally adapted to the necessities of a Bridge Department office, ought to be so flexible as to show forth the information given on Exhibit "F," whether that information relate to bridges, trestles, culverts, viaducts, crossings, or any structure which necessarily comes under the care of a Bridge Department.

d. Pocket Bridge Record Book:

Such a book, with all descriptive data printed in same, is probably necessary on railroads in some parts of America, where small bridge openings and especially trestles are found in such numbers as to make it impossible to readily locate the same by names; however, the Committee does not think that such a book is necessary on railroads where bridges and trestles are few in number and which cross streams to which are attached well-known names.

The value of such a book is appreciated, and a typical form of this character might have been included in the report of the Committee for the information of the members, but the Committee submits no recommended form for such a book, owing to it not being generally required.

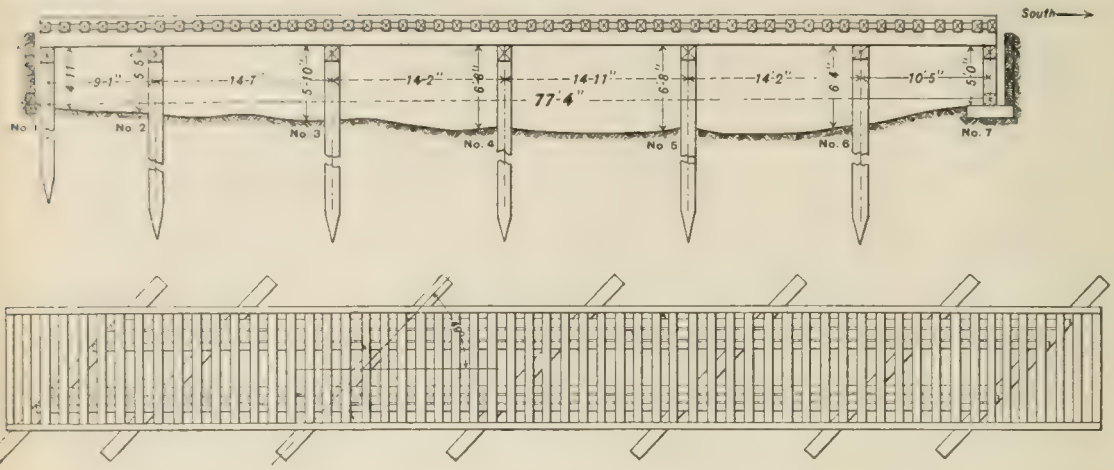
The book, while not being essential or necessary generally, will cer-

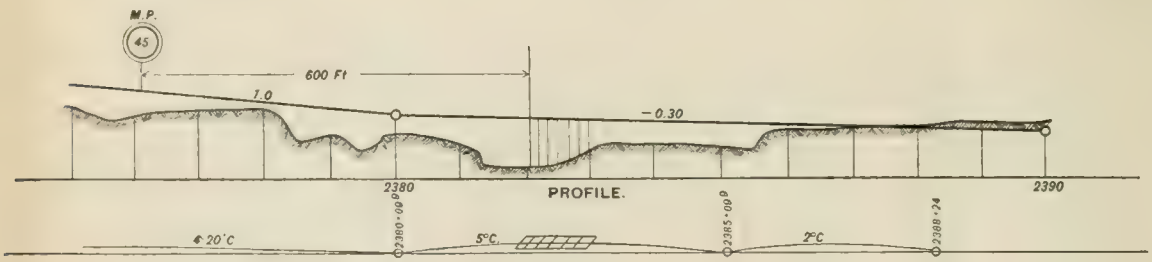
Exhibit "F."

A. B. & C. R. R. Co.

*Bridge No. (new)*_____ *Division*_____

Assumed Load _____ *Bridge No. (old)*_____





ALIGNMENT.

SUPERSTRUCTURE.									SUBSTRUCTURE.			
WEIGHT	@	COST	MATERIAL	YEAR ERECTED	YEAR PAINTED	SAFE LIVE LOAD	DATE OF INSPECTION	CONDITION	MASONRY KIND	CUBIC YDS	@	COST
									TIMBER KIND	B. M.	@	COST

REPAIRS OR ALTERATIONS

EXHIBIT "E."

Am. Ry. Eng. & M

Convention of 19(

Committee on Re

BRIDGE RECO

Exhibit "E"

A. B. & C. R. R. Co.

BRIDGE No.

NAME OF STREAM

DESCRIPTION	BILL OF MATERIAL						INSPECTION			COST OF REPAIRS				PAINT								
	Piece	Name	Dimensions	Piece	Name	Dimensions	Date	Inspected by	Condition	Date		Material	Labor	Total	Date							

Am. Ry. Eng. and M. of W. Assn.
Convention of 1904.
Com. on Records, Reports and Accounts.

Form 672

New York Chicago & St Louis R. R. Co.

Maintenance of Way

Bridge Inspection

Bridges Nos. 21 to 33

Bridge Number	Date 190	Number of Bent	Class	Piles 1	Piles 2	Piles 3	Piles 4	Foundation Class	Foundation Condition	Class	Sill and Intermediate Cap	Posts 1	Posts 2	Posts 3	Posts 4	Cap	Stringers 1	Stringers 2	Stringers 3	Stringers 4	Stringers 5	Stringers 6	Ties.	Guard Rail	Sway Braces	Longitudinal Braces.	Iron	Condition of Fire Protection
21	Dec 3							Concrete	O.K.	Steel													O.K.	O.K.			1-50 ft Plate Girder deck	O.K.
"	" "							"	"	Iron													O.K.				1-27 ft through Iron Girder	"
24	" "		Pile		O.K.			Pile									O.	K.	O.	K.	O.	K.	O.K.	O.K.	O.K.	O.K.		O.K.
25	" "	1						Bank	"	Frame	6	6	6	6	X	6	D.	6	6	D.	6	6	S.	S.	6	6		O.K.
26	" "							Pile	O.K.	Frame	O.K.	O.	K.	O.	K.	O.	K.	O.	K.	O.	K.	O.	K.		O.K.	O.K.	O.K.		O.K.
32	" "							Stone	Piers cracking	Iron							O.	K.	O.	K.	O.	K.	O.K.	O.K.			One "U" nut broken new one ordered	
"	" "							Pile	O.K.	Frame	O.K.	O.	K.	O.	K.	O.	K.	O.	K.	O	K.	O	K.	O.K.	O.K.	O.K.	O.K.		O.K.
33	Dec 1	3						Bank		Frame	S.	3	3	5	5	D	5	6	6	6	6	6	S	S	S	S		O.K.

SYMBOLS
- OK Good for more than one year
- D Dangerous must be removed at once
- 6 Must be removed within 6 months
- S Must be removed within one year
- X Replaced since last report

I hereby certify that I personally made the above examinations on dates named and that this report is correct in every particular.

_____
Inspecter

Exhibit "G"

Exhibit "K"

Am. Ry. Eng. & M. W. Assn.
Convention of 1904.
Com. on Records, Reports and Accounts.

INTERSTATE COMMERCE REPORT DATA.

Engineer M. W. 325

June 30th, 1901.

IMPORTANT. READ CAREFULLY THE INSTRUCTIONS

THE PENNSYLVANIA RAILROAD COMPANY.

N. C. RY., P., W. & B. R. R. AND W. J. & S. R. R.

OFFICE OF ENGINEER MAINTENANCE OF WAY, BROAD STREET STATION,

Philadelphia, Pa.

INSTRUCTIONS.—Where a railroad forms part of a *main line* and also of a *branch line* (as in the case of the Harrisburg, Portsmouth, Mt. Joy & Lancaster Railroad), and where a railroad is *located in more than one State*, a report must be made for *each portion* separately, and also for the *entire line*.

The space intended for reply must in each case be filled out and *never be left blank*.

The information herein required forms a very important element in the records of this office, and these reports must be made up with *great care* and *properly verified* in order to insure completeness and accuracy.

JOS. T. RICHARDS,
Engineer Maintenance of Way.

REPORT OF THE PHYSICAL CHARACTERISTICS OF THE RAIL

ON JUNE 30TH, 1901.

LINE.	Miles.	Hundredths.
Length of road in operation, extending from ____ to ____		
Length of road unfinished, extending from ____ to ____		
Total length when completed, extending from ____ to ____		

TRACK.	LENGTH OF TRACK.		LENGTH OF TRACK LAID WITH IRON RAILS.		LENGTH OF TRACK LAID WITH STEEL RAILS.		WEIGHT OF RAIL PER YARD IN COMPANY'S TRACKS. IRON	WEIGHT OF RAIL PER YARD IN COMPANY'S TRACKS. STEEL
	Miles.	Hundredths.	Miles.	Hund.	Miles.	Hund.		
First track,								
Second "								
Third "								
Fourth "								
Company's sidings,								
Total Company's Tracks,								
Private sidings,								
Total all Tracks,								

TRACK LAID AND REMOVED DURING YEAR. (June 30th, 1900, to June 30th, 1901.)	LENGTH OF TRACK. LAID. Miles.	LAID. Hund.	REMOVED. Miles.	REMOVED. Hund.	NET INCREASE. Miles.	NET INCREASE. Hund.	NET DECREASE. Miles.	NET DECREASE. Hund.
First track, extending from ____ to ____								
Second " " " to ____								
Third " " " to ____								
Fourth " " " to ____								
Company's sidings,								
TOTAL COMPANY'S TRACKS,								
Private sidings,								
TOTAL ALL TRACKS,								

KIND OF RAIL IN TRACK LAID AND REMOVED DURING YEAR. (June 30th, 1900, to June 30th, 1901.)	LAID. STEEL RAILS. Miles and Hundredths	LAID. IRON RAILS. Miles and Hundredths	REMOVED. STEEL RAILS. Miles and Hundredths	REMOVED. IRON RAILS. Miles and Hundredths	NET INCREASE. STEEL RAILS. Miles and Hundredths	NET INCREASE. IRON RAILS. Miles and Hundredths	NET DECREASE. STEEL RAILS. Miles and Hundredths	NET DECREASE. IRON RAILS. Miles and Hundredths
First track, extending from ____ to ____								
Second " " " to ____								
Third " " " to ____								
Fourth " " " to ____								
Company's sidings,								
TOTAL COMPANY'S TRACKS,								
Private sidings,								
TOTAL ALL TRACKS,								

MATERIAL USED FOR REPAIRS.

(June 30th, 1900, to June 30th, 1901.)

NEW RAILS LAID DURING YEAR.

(June 30th, 1900 to June 30th, 1901)

KIND.	TONS.	WEIGHT PER YARD.	Average Price per Ton at distributing point.
Steel,		60 lbs.	
		70 "	
		85 "	
		88 "	
		100 " 60 ft.	
		100 " 30 ft	
TOTAL STEEL,			

NEW TIES LAID DURING YEAR (June 30th, 1900, to June 30th, 1901), AND AVERAGE PRICE AT DISTRIBUTING POINTS.

KIND OF TIMBER.	NUMBER OF TIES LAID. First Class	Average Price	Second Class and Culls.	Average Price	Total Number.	Average Price per Tie of all kinds at distributing points.
TOTAL,						

NOTE.—The average price of Rails and Ties is to be computed and shown in every case. Report all Ties as Oak, Chestnut, Yellow Pine or Miscellaneous.

ALIGNMENT.

LENGTH OF LINE. Miles.	Hund.	Number of Curves.*	Aggregate Length of Curved Track. Miles.	Hund.	Aggregate Length of Straight Track. Miles.	Hund.

PROFILE.

LENGTH OF LEVEL TRACK. Miles.	Hund.	ASCENDING GRADES. (Running East and North.) Number.	Sum of Ascents. Feet.*	Aggregate Length of Ascending Grades. Miles.	Hund.	DESCENDING GRADES. (Running East and North.) Number.	Sum of Descents. Feet.*	Aggregate Length of Descending Grades. Miles.	Hund.

* The component parts of a compound curve lying between two adjacent tangents are to be considered as making only one curve, but in the case of reverse curves, the component parts are each to be considered as one curve.

RAILROAD BRIDGES AND TUNNELS.

BRIDGES. (Spans over openings of 10 feet or more to be classed as bridges.)	TOTAL NUMBER.	TOTAL LENGTH. Feet.*	MINIMUM LENGTH. Feet.*	MAXIMUM LENGTH. Feet.*	TOTAL LENGTH IN FEET COVERED BY 1 TRACK. Feet.*	2 TRACKS. Feet.*	3 TRACKS. Feet.*	4 TRACKS. Feet.*
Stone Bridges,								
Iron "								
Wooden "								
Wooden Trestles,								
TOTAL ALL KINDS,								
TUNNELS.								
All Railroad Tunnels,								

NOTE.

The longest Railroad Tunnel is located at , 15 miles from Station.

The shortest Railroad Tunnel is located at , 15 miles from Station.

* OMIT DECIMALS; GIVE LENGTH IN NEAREST WHOLE NUMBERS.

CROSSINGS.

PUBLIC HIGHWAY CROSSINGS.

CHARACTER OF CROSSING.	Total Number.	Distance of Lowest Point to Base of Rail. Feet.	Ins.
Highway O. H. Bridges,			
" " Trestles,			
" Grade Crossings,			
" Under-grade Bridges (wood or iron),			
" Under-grade Arches (stone or brick),			

RAILROAD CROSSINGS.

CHARACTER OF CROSSING.	Total Number. (Steam Roads.)	Distance of Lowest Point to Base of Rail. Feet.	Ins.	Total Number. (Trolley or Cable Roads.)	Distance of Lowest Point to Base of Rail. Feet.	Ins.
Railroad O. H. Bridges,						
" " Trestles,						
" Grade Crossings,						
" Under-grade Bridges (wood or iron),						
" Tunnels,						

TRACK.	GAUGE OF TRACK. 4 ft. 8½ in. Miles.	Hund.	4 ft. 9 in. Miles.	Hund.
First track,				
Second "				
Third "				
Fourth "				
Company's sidings,				
Total Company's Tracks,				
Private sidings,				
Total all Tracks,				

TRACK.	LENGTH OF TRACK† LAID WITH STONE BALLAST. Miles.	Hund.	GRAVEL BALLAST. Miles.	Hund.	CINDER, CULM AND OTHER BALLAST. Miles.	Hund.
First track,						
Second "						
Third "						
Fourth "						
Company's siding,						
Total Company's Tracks,						
Private sidings,						
Total all Tracks,						

† IN REPORTING BALLAST DEDUCT THE AMOUNT OF UNBALLASTED TRACK ON BRIDGES.

tainly be found useful on particular railroads, and may therefore be classed as desirable.

While no blank known as a Pocket Bridge Record Book is recommended or illustrated by the present Committee, it is thought that this feature of bridge records is worthy of much more careful study than has been given to it during the past year, and some future Committee could render a service to the Association by giving the subject more thorough study.

k. Pennsylvania Railroad Company Blank.

The Committee illustrates herewith a Pennsylvania Railroad Company blank used in reporting annually the physical characteristics of road, whether the same pertain to track or bridges. The blank is illustrated because it is one of the very best examples in use in this country.

CONCLUSIONS.

Your Committee submits to the Association the following conclusions, based on the information given in the report which deals, as stated heretofore, solely with those special blanks which are essential and necessary in a Bridge Department.

(1) The following blanks have been prepared and are illustrated full size:

Daily report of Foreman of Bridges.....M. W. 1000
Monthly Bridge Material Report.....M. W. 1001
Foreman's Diary—Bridge Department.....M. W. 1002
Bridge Department Tool Report.....M. W. 1003
Structure Report .....M. W. 1004
Bridge Inspector's Daily Report.....M. W. 1005
Monthly Bridge Inspection Report.....M. W. 1006
General Bridge Inspection Report.....M. W. 1007

(2) The regular and general blanks of the road should be used in all departments, including the Bridge Department, as far as applicable; for example, one blank for reporting time should be used in all departments, the blank being specially designed accordingly.

(3) The Committee submits, for the information of the Association, certain blanks for the compilation of information for record purposes relating to physical characteristics of road, bridge records, etc., marked Exhibits D, E, F and K. These records, when properly kept up to date in an accurate manner, will prove of the highest value to railroads and are essential for any system of complete and proper bridge records. However, the Committee believes that such blanks are not absolutely necessary, especially for a Bridge Department, but are, rather, necessary generally for the compilation of records of several departments, and hence these blanks are not recommended as standard special Bridge Department blanks.

(4) There are numerous minor blanks used on many, if not all railroads, for reporting information necessary to complete and keep bridge

records up-to-date, but the Committee believes that such blanks will have to be regulated by each individual road, and hence such blanks have not been prepared and no standard forms are recommended.

RECOMMENDATION.

Your Committee recommends to the Association for adoption the eight blanks marked M. W. 1000 to 1007, which should be considered as the necessary special blanks required for the regular working of a Maintenance of Way Bridge Department.

Respectfully submitted,

EDWIN F. WENDT, Assistant Engineer, Pittsburg & Lake Erie Railroad, Pittsburg, Pa., *Chairman;*

GEORGE HOULISTON, Assistant Engineer, Pennsylvania Railroad, Buffalo, N. Y., *Vice-Chairman;*

WALTER G. BERG, Chief Engineer, Lehigh Valley Railroad, New York, N. Y.;

M. L. BYERS, Assistant General Superintendent of Transportation, Baltimore & Ohio Railroad, Baltimore, Md.;

L. F. GOODALE, Chief Engineer, Burlington's Missouri Lines, St. Louis, Mo.;

F. L. NICHOLSON, Engineer Maintenance-of-Way, Norfolk & Southern Railroad, Norfolk, Va.;

F. W. SCARBOROUGH, Engineer Maintenance-of-Way, Chesapeake & Ohio Railway, Richmond, Va.;

J. E. TURK, Superintendent, Philadelphia & Reading Railway, Reading, Pa.;

G. H. WEBSTER, General Tie Agent, Canadian Pacific Railway, Montreal, Canada;

E. K. WOODWARD, Engineer Maintenance-of-Way, Wabash Railroad, Detroit, Mich.;

H. A. WOODS, Engineer in Charge, Grade Reduction and Double Track Improvements, Grand Trunk Western Railway, Detroit, Mich.;

Committee.

AMENDMENTS.

Conclusion No. 6: Three definitions are submitted for adoption:

(a) RECORDS.—Records consist of information or data in graphical, tabular or statement form, relating to the physical characteristics, condition, cost and such other information as may seem desirable for record.

(b) REPORTS.—Reports consist of the medium through which information is transmitted from a subordinate official to a higher official, and from which records and accounts are prepared or compiled in the filing office.

(c) ACCOUNTS.—Accounts cover all statements required to enable payments to be made for labor performed and material furnished, and all statements necessary in order to establish the detail, total and comparative cost of work and various classes of expenses.

Conclusion No. 7: Your Committee recommends that duplicate copies of record books and maps, particularly right of way maps, should be kept in quite widely separated localities, so that the trouble and expense of reproducing the same will be greatly reduced in case of fire or accident.

Exhibit "H"

PENNSYLVANIA LINES WEST OF PITTSBURGH.

-WEST SYSTEM.

ANNUAL REPORT OF THE

SUPERINTENDENT

OF THE

.....

TO THE

CHIEF ENGINEER,

SHOWING OPERATIONS OF MAINTENANCE OF WAY DEPARTMENT

ON THE .....

For the Year Ending December 31st,

I.....

SUMMARY OF TRACK MILEAGE.

TOTAL MILEAGE ON DECEMBER 31, 1 ....., SHOWING KIND OF RAIL IN TRACKS.

CLASSIFICATION OF TRACKS.	KIND OF RAIL.	MAIN LINE.	BRANCHES.						TOTAL.		TOTAL TRACK.	
	Steel,											
Main Track,	Iron,											
	Steel,											
Second Track,	Iron,											
	Steel,											
Third Track,	Iron,											
	Steel,											
Fourth Track,	Iron,											
	Steel,											
Company's Sidings	Iron,											
	Steel,											
Total,	Iron,											

ADDITIONS AND CHANGES DURING THE YEAR ENDING DECEMBER 31, 1.....

CLASSIFICATION OF TRACKS.	KIND OF RAIL.	MAIN LINE.	BRANCHES.						TOTAL.		TOTAL TRACK.	
	Steel,											
Main Track,	Iron,											
	Steel,											
Second Track,	Iron,											
	Steel,											
Third Track,	Iron,											
	Steel,											
Fourth Track,	Iron,											
	Steel,											
Company's Sidings	Iron,											
	Steel,											
Total,	Iron,											

TOTAL MILEAGE ON DECEMBER 31, 1....., SHOWING KIND OF RAIL IN TRACKS.

CLASSIFICATION OF TRACKS.	KIND OF RAIL.	MAIN LINE.	BRANCHES.						TOTAL.		TOTAL TRACK.	
	Steel,											
Main Track,	Iron,											
	Steel,											
Second Track,	Iron,											
	Steel,											
Third Track,	Iron,											
	Steel,											
Fourth Track,	Iron,											
	Steel,											
Company's Sidings	Iron,											
	Steel,											
Total,	Iron,											

INFORMATION FOR REPORT TO COMMISSIONER OF RAILROADS AND TELEGRAPHS OF STATE OF OHIO

INSTRUCTIONS

On pages 4 to 9 inclusive enter information required. Main line to be entered first; branches to follow that part of main line to which they pertain or connect. In entering main track mileage, begin at eastern terminus of road if within State of Ohio; otherwise begin at most easterly point in State, such point to be called 0.

Main track mileage to be cumulative from 0 to each station designated.

Side and yard tracks located within city limits are to be given separately for each locality.

TRACK MILEAGE, STATIONS, RAILROAD CROSSINGS AND GRADE CROSSINGS, AND PROTECTIONS

COUNTY.	NAME OF STATION, RAILROAD, ELECTRIC AND STREET RAILWAY.	DIRECTION. NORTH, SOUTH, EAST, WEST	MILES OF TRACK MAIN LINE.	MILES OF SECOND TRACK.	MILES OF THIRD AND FOURTH TRACK.
Totals,					

JUNCTIONS, STREET AND ELECTRIC RAILWAY CROSSINGS, WITHIN OHIO, DECEMBER 31, 1.....

MILES AND FEET OF SIDE TRACK.		MILES AND FEET OF YARD TRACK.		STREET AND HIGHWAY GRADE CROSSINGS.	NO. WATCHMEN.	NO. GATES.	NO. BELLS.	HIGHWAY GRADE CROSSINGS BETWEEN POINTS.	WATCHMEN.	GATES.	BELLS.	INTERLOCKING.	OVERHEAD.	UNDERWAY.	ELECTRIC LIGHT.

TRACK MILEAGE, STATIONS, RAILROAD CROSSINGS AND GRADE CROSSINGS, AND PROTECTIONS

COUNTY	NAME OF STATION, RAILROAD, ELECTRIC AND STREET RAILWAY	DIRECTION. NORTH, SOUTH, EAST, WEST.	MILES OF TRACK MAIN LINE.	MILES OF SECOND TRACK.	MILES OF THIRD AND FOURTH TRACK.

JUNCTIONS, STREET AND ELECTRIC RAILWAY CROSSINGS, WITHIN OHIO, DECEMBER 31, 1 .....

MILES AND FEET OF SIDE TRACK.		MILES AND FEET OF YARD TRACK.		STREET AND HIGHWAY GRADE CROSSINGS.	NO. WATCHMEN.	NO. GATES.	NO. BELLS.	HIGHWAY GRADE CROSSINGS BETWEEN POINTS.	WATCHMEN.	GATES.	BELLS.	INTERLOCKING.	OVERHEAD.	UNDERWAY.	ELECTRIC LIGHT.

TRACK MILEAGE, STATIONS, RAILROAD CROSSINGS AND GRADE CROSSINGS, AND PROTECTIONS

COUNTY.	NAME OF STATION, RAILROAD, ELECTRIC AND STREET RAILWAY.	DIRECTION. NORTH, SOUTH, EAST, WEST	MILES OF TRACK MAIN LINE.	MILES OF SECOND TRACK.	MILES OF THIRD AND FOURTH TRACK.
Totals,					

JUNCTIONS, STREET AND ELECTRIC RAILWAY CROSSINGS, WITHIN OHIO, DECEMBER 31, 1.....

MILES AND FEET OF SIDE TRACK.		MILES AND FEET OF YARD TRACK.		STREET AND HIGHWAY GRADE CROSSINGS.	NO. WATCHMEN.	NO. GATES.	NO. BELLS.	HIGHWAY GRADE CROSSINGS BETWEEN POINTS.	WATCHMEN.	GATES.	BELLS.	INTERLOCKING.	OVERHEAD.	UNDERWAY.	ELECTRIC LIGHT.

MATERIALS USED IN TRACK.

Steel Rail.

KIND OF TRACK.	LAID IN RENEWAL OF TRACKS OWNED BY THE RAILWAY COMPANY.								LAID IN CONSTRUCTION OF NEW TRACKS OWNED BY THE RAILWAY COMPANY.								TOTAL STEEL RAIL LAID.	
	NEW STEEL.		PARTLY WORN STEEL		TOTAL.		MILES.		NEW STEEL.		PARTLY WORN STEEL		TOTAL.		MILES.			
	TONS.		TONS.		TONS.				TONS.		TONS.		TONS.					
Main,																		
Second,																		
Third,																		
Fourth,																		
Co. Sidings,																		
Total,																		

	60 LB.		70 LB.		85 LB.		TOTAL.	
Tons of New Steel on hand December 31st, 1 ,								
Tons of New Steel received during 1 ,								
Total,								
Tons of New Steel laid during 1 ,								
Tons of New Steel on hand December 31st, 1 ,								

Cross Ties.

Used in renewal of tracks owned by the Railway Company. . . . . Number .....

Used in construction of new tracks owned by the Railway Company . . . . . Number .....

BALLAST.

	KIND OF BALLAST USED.						TOTAL.	
	GRAVEL.		STONE.		CINDER.			
	MILES.		MILES.		MILES.		MILES.	
Placed under Track not heretofore ballasted,								
Renewing Broken Stone,								
" Gravel,								
" Cinder,								
Total,								

FENCING.

New Fences Built During the Year.

	WIRE.		BOARD.		TOTAL.	
	MILES.	FEET.	MILES.	FEET.	MILES.	FEET.
Where not heretofore fenced,						
Renewing Old Fences,						
Total Fences built during year,						
Total Number of Miles of Wire Fence on this Division computed as a single line,						
" " " Board " " " " " "						
Grand Total all kinds of Fence on this Division computed as a single line,						

STATIONS.

New Stations Built During the Year.

LOCATION.	PASSENGER.			FREIGHT.			COMBINATION.		
	CHARACTER.	ROOF.	SIZE.	CHARACTER.	ROOF.	SIZE.	CHARACTER.	ROOF.	SIZE.

TRACKS

Owned by the Railway Company, Laid, Extended or Taken Up.

Business Sidings.

LOCATION.	DESCRIPTION.	ADDED FEET.	TAKEN UP FEET.	INCREASE FEET.	DECREASE FEET.
Total,					

LOCATION.	DESCRIPTION.	ADDED FEET.	TAKEN UP FEET.	INCREASE FEET.	DECREASE FEET.
Total,					

YARD TRACKS.

LOCATION.	DESCRIPTION.	ADDED FEET.	TAKEN UP FEET.	INCREASE FEET.	DECREASE FEET.

OTHER TRACKS ADDED.

LOCATION.	FIRST TRACK. MILES.		SECOND TRACK. MILES.		THIRD TRACK. MILES.		FOURTH TRACK. MILES.		TOTAL. MILES.	
Total,										

RECAPITULATION.

	FIRST TRACK.	SECOND TRACK.	THIRD TRACK.	FOURTH TRACK.	BUSINESS SIDINGS.	PASSING SIDINGS.	YARD TRACKS.	TOTAL.
Added during year,								
Taken up " "								
Net Total,								

NOTE.—Column headed "First Track" is intended particularly for Branches, but in case any change is made in mileage of Main Line it should be shown in this column.

CLOSED CULVERTS REBUILT.

NO.	LOCATION.	NEW STRUCTURE BUILT.												OLD STRUCTURE REMOVED.																							
		SEWER PIPE.		IRON PIPE.		STONE BOX.		STONE ARCH.		SEWER PIPE.		IRON PIPE.		STONE BOX.		STONE ARCH.		TRESTLE																			
		Diam.	Length.	Diam.	Length.	Width.	Length.	Span.	Length.	Diam.	Length.	Diam.	Length.	Width.	Length.	Span.	Length	Length.																			

NO.	LOCATION.	NEW STRUCTURE BUILT.					OLD STRUCTURE REMOVED.				
		KIND OF STRUCTURE	LENGTH IN FEET.				KIND OF STRUCTURE.	LENGTH IN FEET.			
			STONE.	IRON.	WOOD.	TRESTLES.		STONE	IRON.	WOOD.	TRESTLES.
	Total,										

NOTE.—When a trestle has been replaced by embankment, in whole or in part, and no bridge or culvert built, give length of trestle filled, under head of "Old Structure Removed;" and note the word "Embankment" under head of New Structure.

SUMMARY.

_____ Division, Year 1_____

New Steel Rail laid as Renewals..... .....Tons ....Miles.....

Partly Worn Steel Rail from Main Track laid as Renewals " ..... " .....

Total Steel Rail laid as Renewals..... " ..... " .....

New Steel Rail laid in construction of New Tracks..... " ..... " .....

Partly Worn Steel Rail laid in construction of New Tracks " ..... " .....

Total Steel Rail laid in construction of New Tracks..... " ..... " .....

Tons of New Steel on Hand Dec. 31, 1....60lb.....70lb.....85lb.....Total.....

Cross Ties used as Renewals.....Number.....

Cross Ties used in construction of New Tracks..... " .....

Ballast placed under track—Gravel..... Miles.....

Ballast placed under track—Stone..... " .....

Ballast placed under track—Cinder..... " .....

New Fences built during year—Wire..... ..... " .....

New Fences built during year—Board..... " .....

Passenger Stations built. .....Number.....

Freight Stations built..... ..... " .....

Combination Passenger and Freight Stations built..... " .....

Business Sidings—increase in length.....Feet.....

Passing Sidings—increase in length..... " .....

Yard Tracks—increase in length..... " .....

First Track constructed.....Miles.....

Second Track constructed..... " .....

Third Track constructed..... " .....

Fourth Track constructed..... " .....

Bridges built to renew old structures—Stone, Number....Length....Ft. Lin.....

Bridges built to renew old structures—Iron, " .... " .... " ....

NOTE.=All fractions in this report should be shown in decimals.

APPENDIX.

THE DISTINCTION BETWEEN REPAIRS AND IMPROVEMENTS AND A PROPOSED CLASSIFICATION OF RAILROAD MAINTENANCE OF WAY EXPENSES.

By Walter G. Berg.

The distribution of railroad expenses depends frequently on individual judgment, local conditions, special circumstances, and, no doubt, when general broad questions of policy are concerned, largely on the aims of the management in financial matters. Further, there are numerous items of expenditure which could almost equally as well, according to the viewpoint taken, be classed one way or the other, so that the final decision savors often of apparently arbitrary action. The possibility, therefore, of obtaining a general set of rules and short formulas to serve as a universal infallible guide is very problematical.

It is essential to record this opinion at the start so as to forestall adverse criticism, claiming that any attempt to bring some degree of order out of the chaotic system of existing rulings and classifications relating to Maintenance of Way expenses is absolutely futile. As indicated above, many charges will always remain debatable and uncertain, but any attempt to reduce the number of such open questions and to improve and strengthen the accounting system, as far as the bulk of the entries is concerned, should be welcomed as an advance in the right direction.

An examination of recent annual reports of various railroads will impress even a casual observer that one of the leading questions in reference to the Maintenance of Way expenses of the Operating Department is the disposition made in the accounts of the items of Maintenance of Way expense classed variously as Improvements, Additions or Betterments.

There is no uniform practice or rule as to what class of work constitutes properly an Improvement, Addition or Betterment to the property and in how far such items are properly chargeable to Capital, to Income or to Operating Expense. The tendency of the day on many prominent American railroads is to improve the property largely out of Income, with the result of reducing Surplus Earnings to the temporary detriment of the stockholders. On other roads charges to Capital are liberally made, thereby calling for an increase eventually in the capitalization of the road.

The correctness of the underlying principles determining the proper

policy to pursue becomes, therefore, in a certain sense, a question of public interest as affecting large numbers of individual holders of railroad securities. The importance of the question is emphasized by the constant reference to this subject in reviews of railroad reports in the financial press and the care and pains taken by railroad presidents to elaborate in their annual reports on the disposition made of such expenditures for Improvements, the references being either laudatory, explanatory or apologetic, according to the special conditions and results in each case.

The question of the proper subdivision and general classification of Maintenance of Way expenses is, therefore, not purely a departmental detail of interest and value only to the operating officers, but one that, according to the ultimate disposition made by the highest executive and financial officers of the road of certain expense groups of the adopted classification, will prove to have an important bearing on the standing of the company in general financial matters.

The disposition of certain expenditures of the Maintenance of Equipment Department has also a similar bearing on the general financial results, but the division of Maintenance of Way expenses is more complex than the determination of the expense groups of Maintenance of Equipment, such as the proper disposition of charges for additional equipment or shop machinery, and for replacements of old, wrecked or condemned equipment and shop machinery.

It is freely recognized that the ultimate disposition of certain large groups of expenses, especially when general broad questions of financial and corporate policy are concerned, is dependent largely on the aims of the management in financial matters, sometimes based on a fixed policy pursued continuously for years, in other cases swayed from season to season by the particular conditions or emergencies confronting the management at the time. It is not contended that the settlement of these general questions falls within the sphere of the Maintenance of Way Department, but the grouping of the expenses as carried out in detail by the Maintenance of Way officers forms the basis of the accounting system and hence should be conducted on suitable and practical lines.

The tendency of many engineers and operating officers is to follow absolutely the requirements and forms prescribed by the Accounting Department and to consider that the Auditing officials are adverse to receiving advice and assistance. On many roads, however, accounting officers recognize their dependence on the operating officers for the introduction of practical accounting systems, and engineers should take their part in attempting to produce the best results, by outlining and advising the accounting officers of such changes in the accounting system as would appear of benefit, not only in the subsequent disposition of charges for Additions and Betterments, but also serving to give a more reliable basis for comparisons of expenses; in other words, the obtaining of groups of figures which will allow correct deductions to be drawn as to the relative "operating efficiency" and unit costs of maintenance, as between the several divisions of a road or the expenses of different periods.

A discussion, therefore, of the principles and questions involved and the various classes of work and expense groups, forming the total expense charged usually in the first instance under the head of Maintenance of Way to Operating Expenses, should prove of value to all Maintenance of Way engineers and general railroad officers. It will not only serve to direct attention to the proper differentiation of the various expenses of the department for use in making valuable comparisons and general grouping of expenses already incurred or for forecasts for the future, but will tend, possibly, to promote a more general and uniform practice, and thus make comparisons between different railroads of practical value.

The terms Improvements, Additions, Betterments, Extraordinary Expenses, Maintenance Account, Capital Expenditures, etc., are used today frequently without any absolutely positive or uniform meaning in railroad accounts, railroad annual reports, financial articles, reports of State, Interstate and Government officials. The effect of the determination and ultimate disposition of certain of these classes of expenditure is so far-reaching and affects the general financial results to such an extent that it would seem desirable to establish clear definitions and uniform practice in the grouping of such items. The highest accounting officer of one of the prominent railroads of the country has stated to the writer that, in his opinion, the question was of sufficient importance to warrant official consideration by the American Railway Association, and, in connection with the Maintenance of Way branch of the subject, it seemed to him that, as a preliminary to subsequent action by the American Railway Association or Association of Railroad Accounting Officers, it would be desirable to have some such body as the American Railway Engineering and Maintenance of Way Association discuss the question of the general classification of Maintenance of Way expenses, more particularly with a view to establishing some definition or general rules for guidance in determining what constitutes Additions and Betterments to a railroad property.

This suggestion and the fact that the writer has for a number of years given considerable thought to the subject and has also been instrumental in establishing the classification and grouping of expenses in the Construction and the Maintenance of Way Departments, form the excuse, if any were needed, for the presentation of this paper to the American Railway Engineering and Maintenance of Way Association.

It is hoped that the paper may tend to produce a good discussion and subsequently a more thorough treatment of the subject and possibly definite action by representative Railroad Associations who can deal authoritatively with the subject, thereby promoting a clear understanding, better results and uniformity of practice throughout the country.

I. GENERAL GROUPING OF MAINTENANCE OF WAY EXPENSES.

The Maintenance of Way Department of a railroad is required to carry on all classes of work in the nature of repairs, improvements and, in many cases, even construction, and it is through the medium of the

accounts that the cost of the work has to be charged out and subdivided. Construction work proper, i. e., new facilities, branch lines, etc., is generally in the start recognized as properly chargeable to Capital and charges ordered billed out direct accordingly. All other expenditures, however, are usually charged in the first instance under the head of Maintenance of Way to Operating Expense. Subsequently, in many cases, the accounting or financial officers transfer certain groups of expenses to other accounts, and items that are clearly in the nature of Improvements on the property, while left charged to Operating Expenses, are separated from the expense of maintenance proper and placed under a separate head in the financial showing of Operating Expense.

The grouping of the Maintenance of Way Department Expenses must, therefore, be such as to allow of the clear separation of all items of what might be called irregular work, i. e., not actually maintenance, and, further, such division of the actual maintenance items as to give valuable comparative information on a uniform basis for each division of a road and for any particular period or periods under consideration.

Where expenses are not properly grouped, it is impossible to draw valuable conclusions as to the operating efficiency, to make comparisons, or to satisfactorily explain any unusual variations in expenses for any section of road or period. Without such grouping the irregular work and extra expenses, dependent on contingencies of all kinds occurring at any moment in railroading, will effectually block any attempt to readily ascertain the correct unit cost of maintenance proper. Increased expenses are easily explained by subordinate division officers by calling attention to the irregular and unusual amount of work they had to perform. Where more detailed explanations and proofs are demanded, it is customary to "dig out" of the accounts certain figures and make an ex-parte statement, prepared for a particular purpose, not forming part of the regular accounting system, and hence of no permanent record value.

In any system of accounts it is preferable to adopt a number of general groups in the start, which should form part of the regular system and be uniform for the various offices of the department over the whole road. The increased routine clerical labor in making these various subdivisions in the monthly accounts is small compared with the extra time required and disturbance caused continually by sudden calls from the higher officers for information bearing on a certain class of expenditures. If retrenchments are contemplated, the Division Engineer and Engineer Maintenance of Way must be able to state just what the minimum, i. e., actual expense of maintenance is, independent of all unusual or contingent work. If there has been a series of bad storms, information will be demanded for the extra expense incurred during a certain period for such contingent expenses. If additional money is available, information is required, on short notice, as to the expenses for various classes of work and forecasts for necessary or desirable expense for a future period. Finally, in connection with the preparation of periodical financial statements to be issued to the press or the desire

of the Directors to forecast the probable earnings, statements are required, on short notice, to show the amount of expenditures classed as Additions and Betterments which might be withdrawn from Operating Expenses. It has been thought desirable to enumerate these features somewhat in detail, so as to indicate that the Maintenance of Way officials must be prepared to answer questions promptly as to the total expense of certain classes of work, and that it is, therefore, desirable to establish a number of general groups of expenditures and carry these in the accounts right along. In such case the monthly, quarterly or annual summaries will serve to answer many questions, unusual expenditures are more readily explained and understood, and true comparisons of the regular expenses for maintaining the property can be made on a reliable and practical basis.

Most railroads have two groups of Maintenance of Way expenses, one representing "Repairs," the other "Improvements," the latter embodying, as a rule, the expenses for large special jobs not connected with maintenance proper. Other railroads have three distinctive groups. All engineers connected with Maintenance of Way will recognize that there are many jobs which it is hard to classify in their entirety to one or the other group, even where there are three groups. The writer outlined in 1898 and assisted the Comptroller of a prominent railroad in introducing a system with three groups, called "Current Repairs," "Extraordinary Work" and "Improvements," with a supplementary sub-group for Current Repairs, called "Special Repairs," which sub-group, however, did not go beyond the office of the Engineer Maintenance of Way. This system has worked well, excepting that, when for financial reasons it came to separating the "Additions and Betterments," the adopted grouping was not perfect, as all jobs of each group could not be taken in the aggregate as absolutely representing Additions or Betterments or Repairs, and hence special statements independent of the regular accounting system had to be prepared. Further, the Current Repairs group had to be separated and analyzed by specially prepared statements.

While, in many cases, the management may not care to have Additions and Betterments specially and particularly emphasized and made a part of the original records of the originating accounting offices of the Maintenance of Way Department, the writer believes that, if the management is ready to adopt a fixed policy on this subject to be continued from year to year, then it is desirable to have the grouping to Additions and Betterments a fundamental one, embodied in the accounts at the start. In such case, the personal equation or the policy of temporary expediency in the ascertainment of Additions and Betterments would be largely eliminated and the sums set apart yearly as expended for such classes of work would be more positive and less liable to have the bona fide character of the charges questioned, than would be the case if certain large expenditures that had not been distinctively grouped in the lower accounting offices are subsequently in the financial department apparently arbitrarily extracted from the general so-called Maintenance Expense and classed as Additions and Betterments, or charged to Capital

and utilized subsequently as the basis for increasing the capitalization of the company. In the first case, the character of the expense is well recognized and emphasized from the start, and the method of charging in the first instance to Maintenance of Way expense is merely a convenience and incident to the manner in which the work was carried on. If the item is left in Operating Expenses or made payable out of Income at the end of the year, it stands out prominently, as an Improvement to the property, and can be picked up at any time in later years as an unpledged asset and additional credit obtained on the basis of the bona fide character of the expense as more particularly evidenced by the special grouping starting with the original entries.

It is evident, therefore, that we are confronted at the start in this discussion with the feature that, while all companies will readily recognize the value of a better and more practical differentiation and grouping of the actual maintenance expense, i. e., repairs proper, they will disagree on the desirability and expediency of establishing and tying themselves up to a fixed policy as regards the determination of Improvements, i. e., Additions and Betterments, to the property.

For the purposes of this paper it has been thought best to discuss the subject from the standpoint of a strong road pursuing a settled financial policy from year to year, and hence ready to establish, promulgate and follow fixed rules and standard methods in the grouping of the accounts, without any reference to possible variations that a changeable policy or temporary expediency measures might dictate on other roads. Where it is desired to leave more freedom of action from year to year, the principles and desirable grouping methods will still hold good, but their application can be modified so as to leave the ultimate determination as to the inclusion or exclusion of the groups of Additions and Betterments in any particular account to the higher financial officers.

It would seem desirable to classify all Maintenance of Way work under the following general groups:

A. "Current Repairs"—(Regular annually recurrent repairs).

B. "Contingent Repairs"—(Large emergency expenditures due to sundry contingencies, such as severe storms, floods, accidents, etc.).

C. "Special Repairs"—(Minor items, not distinctly regular repairs, but necessarily permanently chargeable to Maintenance Account).

D. "Extraordinary Repairs"—(Extensive renewals or large non-annually recurrent repairs).

E. "Betterments"—(Increase in value due to permanent improvement of existing facilities).

F. "Additions"—(Additions and New Work not charged in first instance to Construction).

G. "Construction"—(New Work and facilities chargeable to Capital).

Charges to "Construction," when the work is done by the Maintenance of Way Department, are usually billed out direct, so that the

generic grouping of the Maintenance of Way expenses will prove to be under six heads, as follows:

"R"—*Repairs:*
- "A"—Current Repairs.
- "B"—Contingent Repairs.
- "C"—Special Repairs.
- "D"—Extraordinary Repairs.

"I"—*Improvements:*
- "E"—Betterments.
- "F"—Additions.

This grouping offers the following advantageous features:

1. Repairs and Improvements are kept distinct.

2. All work, both Repairs and Improvements, is grouped in the order of its necessity, i. e., in case retrenchments are contemplated the groups at the head of the list are the important ones that must continue, whereas work embodied in groups towards the bottom of the list can be more readily omitted or suspended. Thus it is known that Current Repairs must proceed, so to say, independent of the financial status of the company. Contingent Repairs may not be an important item if the casualties are not serious during the year, and temporary repairs will frequently tide over to the next fiscal period. Special Repairs can largely be ordered stopped. Extraordinary Repairs embodies large renewals or repairs which frequently can be deferred for a year or longer if necessary. Some Betterments will be made even in times of money stringency, but the bulk of such Betterment work, and more particularly Additions, can be postponed indefinitely without stopping the operation of the railroad, although causing a loss of revenue or increased operating expenses.

3. Repair work is subdivided so that the group of Current Repairs will offer valuable comparisons between work on different sections of the road or during different periods, and will allow unit costs of practical value to be established as indicative of the operating efficiency, while large unusual expenses, which are of an irregular and fluctuating nature, dependent upon contingencies and special conditions of all kinds. will be properly indicated and separated from the regular expense of maintenance.

4. Improvement work is not only brought out distinctly by itself but is suitably subdivided to Betterments and to Additions, the two principal classes of work covering Improvements. Betterments, consisting generally of the increment in value due to improving an existing facility, is not as positive and of the same importance or convincing character as absolutely new work under the head of Additions.

5. The various work of the Maintenance of Way Department is grouped in the list practically in the order of its importance with reference to the officer usually authorizing same. Thus, for example, assuming a full Division Organization on a large road, Current Repair work is directly in charge of the various Supervisors, under control of the Division Engineeer; Contingent Repair work, caused by emergencies

and casualties requiring large extra forces, is directly looked after by the Division Engineer, advising with the Division Superintendent; Special Repair work should be authorized by the Division Superintendent consulting with and receiving instructions from the Engineer Maintenance of Way; Extraordinary Repairs should not be undertaken without a special order of the Engineer Maintenance of Way, consulting with the General Superintendent or General Manager; Betterments should be authorized by the General Superintendent or General Manager, consulting with his immediate superior; Additions should be authorized by the General Manager, or for important work by the President; Construction (i. e., all charges to Capital) should be authorized by the President, who, in all large undertakings, would report to the Board of Directors.

Assuming the above indicated general grouping as being worthy of adoption, it will be necessary to establish rules for definitions for the various classes of work to be covered by each general group, further to discuss the best subdivisions of each group, and finally to indicate how this system can be practically carried through without serious difficulties, complications or extra clerical expense.

II. DEFINITIONS COVERING CHARGES TO "REPAIRS."

"A"—Definition of "Current Repairs."

The term "Current Repairs" is defined above briefly as "Regular annually recurrent repairs." It should embrace all classes of expenses that are, so to say, fixed charges or that have to be incurred right along, year in and year out, for the regular maintenance and safety of the railroad property. More specifically, it should aim to embrace all such regular items of expenditure that are comparable for different sections of the road and for varying periods through the medium of comparative statistics and unit costs. To give these comparative figures value it is absolutely essential that all unusual expenses of an irregular, non-annual, special or contingent character should be separated so as to leave Current Repairs on a uniform basis.

Care must be taken not to allow this exclusion process to be carried to extremes, as the regular maintenance forces must necessarily attend to all kinds of small duties which thus become part of their regular work. Thus, salting switches, cleaning switch leads and clearing the tracks after ordinary snowfalls, repairing minor damages to roadbed, ditches, small culverts or telegraph line, due to a local storm, etc., should be classified as Current Repairs as long as the regular forces take care of the same. In case the trouble is so extensive as to cripple the road temporarily and call for large extra emergency forces, then the charging of the extra expenses thus incurred to Contingent Repairs is warranted.

To use an apparent contradiction, the inclusion and exclusion of charges under Current Repairs should be on a liberal as well as on a conservative basis; or a better way of expressing it would be that all questions should be handled in a consistent and practical manner. All large items for irregular work, which interfere with the uniformity of

the Current Repairs account and render comparative statistics of questionable value, should be liberally excluded. On the other hand, conservatism should be shown by allowing small items of expense for all kinds of irregular work to be included as Current Repairs, even if the work in question is not distinctively in the nature of repair work, but nevertheless work that the Maintenance of Way Department necessarily has to perform as part of its regular duties. In other words, regular and uniform classes of work in the various seasons of the year that have to be attended to right along by the minimum regular maintenance forces, maintained throughout the various periods of the year for such purposes, under practically the same conditions on all sections of a road and corresponding to the generally recognized practice on all roads, constitute proper charges to Current Repairs.

The following definition for Current Repairs is proposed:

"Current Repairs" to consist of regular, constant, annually recurrent expenditures for repairs and sundry minor work, required regularly from year to year to maintain in an economical and efficient manner the physical condition of the property and keep the track and structures in shape and safe for operation, embracing all charges for superintendence, labor, materials and sundry items, in the nature of fixed expenses, regular forces, or customary material purchases, necessarily required for the regular maintenance of the property and the safety of the track and structures; provided, such charges are not in the nature of large expenditures incurred for unusual, unforeseen contingencies, for large special requirements not distinctly repair work or not uniform on all sections of a road, or for extensive non-annually recurrent repairs or renewals.

"B"—Definition of "Contingent Repairs."

The term "Contingent Repairs" is defined above briefly as "large emergency expenditures due to sundry contingencies, such as severe storms, floods, accidents, etc." This group of charges is in all cases distinctly repair work of an unusual, unforeseen character. It can be anticipated in a general way in forecasts of probable expenses by averaging the experience of previous years, but there is no certainty in the matter, as it is dependent on the elements and casualties of all kinds. If an intelligible analysis and comparison of regular maintenance expense are desired, the charges for such work must be placed in a separate group. This separation should not be driven to extremes, as the regular forces are expected to repair minor damages of all kinds independent of all causes. When, however, the damages are unusual or extensive, necessitating extra forces and large expenditures, the expense should be classed as Contingent Repairs.

Thus, clearing the track after ordinary snowfalls, righting a few telegraph poles blown down by a storm, cleaning ditches, culverts or roadbed from mud washed down by an ordinary rainfall, repairing slight damage to track or bridge ties by derailments, when attended to by the regular maintenance forces, without any unusual concentration of these forces or employment of extra forces, should be considered as part of the

regular or Current Repair work of the Maintenance of Way Department. If, however, there is a large concentration of forces, such as bringing up section men from neighboring sections, sending work trains from distant territories, employing large special extra gangs, rushing materials from emergency stocks, and large and unusual expenses generally, then the expense should be charged to "Contingent Repairs."

In regard to snowfalls, the decision is somewhat dependent on individual views. Running flangers and engines equipped with snow shields occasionally to keep the track cleared during ordinary snowfalls could be classed as a current expense. If, however, snow plows and extra engines to buck heavy snowdrifts are ordered out, then the expense would be contingent.

In regard to fires and burnouts a similar distinction could be made. If a small section of a fence is burnt or some ties destroyed by fire, the damage would be repaired as a matter of course by the regular repair forces as a current repair, but if a trestle or building is destroyed it would be a contingent expense.

The following definition for Contingent Repairs is proposed:

"Contingent Repairs" to consist of unusual, unforeseen expenditures, due to severe storms, floods, fire, accidents and casualties of all kinds, necessitating expensive emergency work and, in many cases, subsequent extensive repairs or renewals; provided, such work is not of such a comparatively small nature as to belong properly to the uniform and routine work of the regular Maintenance of Way forces, even if the expense is caused by an unforeseen contingency.

"C"—Definition of "Special Repairs."

The term "Special Repairs" is defined above briefly as "Minor items, not distinctly regular repairs, but necessarily permanently chargeable to Maintenance Account." This group might be classed as embracing in the main all miscellaneous charges not properly belonging to any of the other groups. It is necessary so as to create a depository for many numerous, generally small charges, for work performed, materials furnished or sundry expense bills, which cannot be classed as Current Repairs, Contingent Repairs, Extraordinary Repairs, Betterments or Additions, and yet which have to be absorbed permanently under the repair account. It will relieve Current Repairs of many items which tend to invalidate the comparative value of the Current Repairs group, particularly where such items are due to special local conditions. Thus, a section or carpenter repair force, located near a main shop system, a general office building, junction yards, or a terminal, will be called on to do odd chores of all kinds not comparable with the class of work of similar forces on other sections of the road. As long as the work is distinctly regular Repair work or of sufficient importance to be classed as a separate Improvement, it can be properly placed; if not, then Special Repairs forms a convenient depository for the item.

The following examples will illustrate the class of minor jobs that would fall under the head of Special Repairs: Moving a water crane

to a new location; cutting a new track door or additional windows in a roundhouse or shop building; extending engine pits or moving smokestacks in a roundhouse to suit a new class of large engines; additional office or station furniture; changes or additions of partitions, shelving, etc., in offices and buildings; reversing crossovers; minor changes in yard leads or sidings; new fence around a station; small platform extensions; additional buckets for a coaling plant, etc.

This account will also frequently serve to embrace small jobs in the nature of irregular new work or repairs, which should, for better comparative results, be excluded from Current Repairs and yet which are not important, extensive or large enough to warrant being classed as Extraordinary Repairs, or as an Improvement to the property.

The following definition for Special Repairs is proposed:

"Special Repairs" to consist of such minor items, necessarily permanently chargeable to Maintenance Account, even if not distinctly repair work, which items, if charged to Current Repairs, would tend to vitiate the comparative statistical value of the Current Repairs Account, or which items are too small and the work too insignificant to warrant charging to Extraordinary Repairs or classing as a permanent Improvement of the property.

"D"—Definition of "Extraordinary Repairs."

The term "Extraordinary Repairs" is defined above briefly as "Extensive renewals or large non-annually recurrent repairs." This group of charges embraces all large renewal or repair jobs which are not uniform from year to year, owing to the feature that the structure or facility in question only gives out, requiring renewal or thorough general overhauling, after a certain life and in the interim is maintained by ordinary current repairs. Other buildings and structures may have become antiquated or require changes to keep up with the trend of improved methods, and yet the changes may not constitute any visible increase in the value of the railroad property. It does not seem correct that such unusual heavy expenses, which may or may not concentrate in one year, should figure in Current Repairs, thereby destroying the comparative value from year to year of the Current Repairs group. While this work is distinctly Repairs in the broad sense, and, if charged to Extraordinary Repairs, will be so considered, it should be brought out separately from the other classes of repairs. Frequently it is not absolutely necessary that the work has to be done at once, and, while desirable, it can be postponed until another working season, if the financial condition of the company does not warrant it. This, in itself, constitutes a vital distinguishing feature as between Current Repairs and Extraordinary Repairs.

There are other classes of work that should be properly grouped under Extraordinary Repairs, mainly as a matter of convenience and to avoid making a fifth sub-group under the general head of Repairs. There are charges which, while apparently corresponding to the general character of Special Repairs, are so large, or for such extensive work, when taken in the aggregate, as to make it undesirable to charge same

under Special Repairs. Further, there are in many Improvement jobs certain elements of work and expense that cannot be readily separated and executed independent of the elements of Betterments and Additions covered by the job, and hence, as all the work has to proceed at the same time, the relative determination of Additions, Betterments or Repairs must be left for such division as may be decided on as the basis in charging out the total expense. For a job, therefore, where Improvements and Repairs have to go on at the same time, all items of expenses which cannot be charged as a Betterment or Addition must be considered Repairs, and as such chargeable to Extraordinary Repairs, unless special reasons exist for charging to one of the other sub-groups of Repairs.

The following examples will serve for further elucidation of the proper charges to make to the various groups of Repairs.

In a roundhouse, the repairs of a leaky roof would be Current Repairs; the replacement of a seriously damaged section of the building, due to an explosion of a boiler, would be Contingent Repairs; the shifting of smokestacks, lengthening pits and widening doors to accommodate a new large type of engines would be Special Repairs; renewing the entire roof or floor, or rebuilding practically the entire structure with same class of materials and without any vital changes, would be Extraordinary Repairs; renewing a timber or part timber structure with a first-class nominally fireproof building, or adding a small machinery shop annex, would constitute a Betterment, part of the total expense being chargeable to Betterments and the entire balance to Extraordinary Repairs, unless some of the expense was incurred for, say, cleaning out some old stopped-up drain pipes, in which case such part of the expense would be chargeable to Current Repairs.

The following definition for Extraordinary Repairs is proposed:

"Extraordinary Repairs" to consist of large non-annually recurrent repairs or extensive renewals in the nature of maintaining the property; provided, such work does not constitute a Betterment or Addition.

III. DEFINITIONS COVERING CHARGES TO "IMPROVEMENTS."

The general broad term "Improvements" can be and is used to signify any work done or expense incurred on a railroad presenting some element of advance in adopted methods or better facilities tending to improve the service or produce economies. In accounting systems, and more particularly in connection with Maintenance of Way accounts, the term stands for such work and expenses as create a specific or general physical improvement of the property in the form of a Betterment or an Addition.

The terms "Additions and Betterments," "Additions and Improvements," "Improvements and Betterments," etc., are used promiscuously and apparently interchangeably without much thought. The fact, however, that a dual term is usually employed is significant as indicating that intuitively recognition is given to the feature that there are two distinctive classes of charges.

In order to clear the field for the purposes of this discussion, the

term "Improvement" has been adopted as the general term embodying all charges to Maintenance of Way not distinctly chargeable to "Repairs." Further, "Improvements" is considered as composed of two groups of charges, viz., "Additions" and "Betterments," differing in their nature from each other, but both embodying charges that are distinct from "Repairs."

As previously indicated, the ultimate disposition of the group of charges embraced under the collective term "Improvements" is a matter for decision by the executive officers, and, according to the financial policy or aims of the management, it is variously classed as Operating Expenses, or shown as an Improvement of the property made out of Earnings, or charged to Capital.

The general aim of this discussion is to establish what constitutes "Improvements," not so much with a view to determining what items are properly chargeable to Capital, but more particularly to settle what items of Maintenance of Way expenses charged to Operating Expenses or paid out of Income should, in any critical analysis, comparison or explanation of expenses, be considered as a separate group of expenses representing Improvements, i. e., Additions and Betterments, to the property, and be thus kept distinct from the expenses for the regular maintenance and operation of the road, thereby offering a better chance for valuable comparisons as to the actual operating efficiency. If this separation is made, the additional advantage will be obtained that the management can present to the stockholders statements, based upon actual bona fide separations in the accounts, as to the money spent on permanent Improvements out of Earnings and receive credit accordingly. Further, the group of Improvements expenses will stand out as a special item in the financial statements and can be drawn on some day, if required, as an unpledged asset for strengthening the company's credit in financial operations.

The importance of the subject and the desirability of discussing and analyzing the underlying principles and establishing certain leading definitions would seem apparent.

The principal feature of a definition proposed some years ago by a member of a committee of accounting officers appointed for the purpose was:

"The term 'Additions and Improvements' represents all items which the management may decide to be chargeable to Income which might be properly classed as Additions to property for which securities could be issued. In addition to this actual Betterments to existing plant."

This definition fails in not being specific, but it is significant in that it actually represents, unfortunately, the practice governing the determination of the question on many leading railroads of the country.

The purpose of this paper is to aim to answer the question more exhaustively and specifically, subordinating the feature relating to the possibility of raising securities as the guiding principle, without, however, losing the advantage that the group of "Improvements" expenses could and may be utilized for such purpose.

Omitting consideration of "Construction" expenses, i. e., new rail-

roads, extensions of routes, new terminals, etc., which items are properly chargeable direct to Capital, there are two principal classes of expenses incurred by the Maintenance of Way Department, and usually charged to Maintenance of Way in the first instance, which may, according to the viewpoint taken, be considered as Improvements to a railroad property, viz.:

A. "Additions" to the property, something entirely new, as new tracks, buildings, bridges, structures, etc.

B. "Betterments" to existing facilities, where an existing track layout, structure, building, bridge, etc., is permanently improved by rebuilding, replacing or remodeling same.

Of these two classes, the first one, Additions, is the strongest with respect to possible ultimate charging to Capital, as it is more clear-cut and offers more visibly a direct Improvement without any complications. On the other hand, the second group, Betterments, is complicated by being connected more or less intimately with existing facilities and structures, and the expenses are incurred coincidently with extensive repair work; hence the division of the total expense has to be based on estimates, or, in some cases, on apparently arbitrary distinctions, as to what element or proportion of the work is properly a Betterment in contradistinction to Repairs.

The essential element influencing the classing of any item of expense as "Improvements" to the property consists in the feature that such expenses must have permanently raised the value of the property, i. e., its market or selling value. This may be due to one or a combination of several of the following four principal contributory causes:

1. Adding tangible assets to the real property in case of appraisement for a sale.
2. Tending to reduce permanently the yearly maintenance expense.
3. Tending to increase permanently the earning capacity.
4. Tending to reduce permanently the operating expense.

The first two items can be considered as "Direct Causes," due to visible tangible proofs and not easily controverted if the conditions warrant the claim.

The last two items can be considered as "Indirect Causes," based on assumptions and estimates of the operating and traffic officials of the probable results that will be accomplished, which, never mind how good and expert the judgment of these officials may appear at the time, are subject to change in the controlling conditions in the future and hence open to criticism and individual opinion as to the stand taken, until the correctness of the assumptions and estimates is demonstrated by actual results for a long period afterwards.

Assuming that all expenses for Improvements are made after careful analysis of the necessities in each case and the work executed properly and economically, tending to produce one or more of the four contributory elements mentioned above as necessary to raise the value of the property, then, in a general way, it is apparent that the determination of Improve-

ments due to Additions will not prove as difficult and complicated as the questions affecting the definition of Betterments.

One of the most difficult and important questions in connection with the definition that an Improvement must tend to permanently raise the "value of the property" consists in the view or method adopted for appraising such value. Theoretically, there is only one real value to a property, but anyone with experience will endorse the statement that, unfortunately, railroads are valued in many different ways by the various interests and on the basis of many personal views and theories.

According to the particular purpose in mind or aim to be attained, viz., selling, buying, taxing, capitalizing, mortgaging, attacking or justifying tariff rates, etc., the various methods involve the questions of real and personal property, value of franchise, earning power, physical condition, strategic position, market price of securities, volume and density of business, trade outlook, etc., all of which influences are, more or less, considered in many of the propositions advanced for appraising the value of a railroad plant.

The general maxim in law is that the market value constitutes the true value of a property, and that this is established on the basis of an owner willing to sell and a buyer willing to purchase.

The value of a railroad property is a very fluctuating quantity, and no general rules seem to apply in all cases where value is to be appraised. The term "actual value" sounds positive, but it has no distinctive meaning unless the basis on which it is to be determined is settled and the methods of appraisement specified.

"A"—Definition of "Additions."

The term "Additions" is defined above briefly as "Additions and New Work not charged in first instance to Construction."

At first thought it might appear self-evident that any Addition to the property in the form a new track, structure, etc., where nothing of the kind existed previously, would necessarily constitute an increase in the value of the property, and hence be properly chargeable as an "Improvement." This assumes, however, that every new facility on a road must necessarily be a money-maker or a money-saver, if the work has been executed with proper care, economy and of proper design, and that good judgment has always been displayed by the proper officers of the Operating and Maintenance of Way Department in settling on any new facilities desired. It would be impossible for an accounting officer to base the division of the expense on an analysis of this point, to be made under his direction, so that it seems perfectly correct to accept, as a general ruling, that all new work and new facilities duly authorized must be accepted by the Accounting Department as tending to raise the value of the property.

This view is substantiated further by the feature that in any appraisement of the property by outsiders the actual tangible and visible property, such as tracks, buildings, structures, bridges, signals, roadbed, auxiliary appliances and fixtures, are necessarily included and inventoried at

their value based on the physical condition they are in at the time of the appraisement. The appraisers may subsequently arrive at some conclusions and make some deductions or additions for the value of the whole property, owing to alleged poor or high-earning capacity, or more or less favorable operating expenses, or special features of the road, but it is not conceivable that they would, to any great extent, single out individual structures or pieces of track and analyze carefully the importance and necessity of same in connection with the operation and earning capacity of the road as a whole and make separate deductions for such facilities. Of course, it is readily understood that a road showing at many points at first glance a lack of good judgment in existing facilities and structures will be heavily mulcted in any appraisement of its value and be reported far below its book-values.

It does not appear feasible, however, to premise an accounting system of a large first-class road on any other basis than that all new work or additions to the property must necessarily be classed as raising the permanent value of the property, as long as it is properly maintained and improved and remodeled from time to time as may prove necessary to keep up with the progress of the best railroad practice. All accounting charges to Capital Account or permanent "Improvements" to the property are necessarily based on the same idea, viz., that after the first cost of a certain structure or facility is charged out, thereby creating an addition to the book-value of the property, the structure is properly maintained and not allowed to depreciate physically or deteriorate so as to become a money-loser. In practice this is not always done to as full an extent as it should be, and hence frequently the resulting shrinkage in actual value as compared with the book-value of the property. This is particularly so when charges are made wholesale to Capital. When, however, "Improvements" are largely absorbed in the Operating Account in addition to the ordinary regular current maintenance, or paid out of income, the balance between actual and book-value of the tangible physical property of the road is much better maintained. The practice of a number of prominent and successful railroads in dividing their income has been tersely described as "A dollar to Improvements and a dollar to Dividends."

It is evident that this general ruling, that any absolutely new structure or facility added to the property tends to raise the valuation of the property, is open to criticism as being too sweeping. It may be that poor judgment was used by the operating officers, or the particular new facility added to the property is not distinctly a money-maker or money-saver, or it is simply rendered necessary so as to keep up with the latest improvements of railroad methods, or it may be necessary so as to retain certain traffic that would otherwise be lost. Again, a new highway may be opened and the laws require the railroad to assume part of the cost of the bridge over the railroad. In this case, however, the assumption is, that if there was no railroad at this point, and a new railroad was to be built, it would have to build this bridge, hence the bridge becomes a necessary part of

the railroad property and enters into its value as far as based on cost of construction.

As above indicated, the writer fails to see any practical method of definition by which an accounting system or set of rules can be made superior to the judgment and decision of the proper operating and executive officers as to what new work is necessary, and when they have so decided, the presumption must be, in the absence of other proof, that the new work is of permanent value or is a necessary part of the railroad, i. e., an Improvement in the nature of an Addition.

Separate special orders should be required for all new work, i. e., Additions to the property. Such orders should be passed on critically by someone detailed for this duty in the office of the chief operating officer, so as to determine whether the work in question properly tends to raise the value of the property, and hence is properly chargeable as an Addition to "Improvements." This group of charges would then always stand out separately in the Operating Accounts and represent the expenditures for New Work properly chargeable as "Additions" to "Improvements."

There is hardly any New Work of any magnitude that does not carry with it one or more of the four contributory elements mentioned above as tending to increase the value of the property, more particularly the first one, viz.: "Adding tangible assets to the inventory of the real property in case of appraisement for a sale." It is this feature that should govern largely in this question. With New Work, well constructed and properly maintained, there is generally something tangible to show to appraisers or prospective purchasers of the property, and if the track, structure or facility under examination is in good condition and apparently needed for the proper conduct of the business, and is not of an antiquated design or pattern, it will be accepted as a necessary part of the whole road and valued according to its physical condition.

An answer to this line of argument is, however, the claim that the purchase value of a road is based more on its earning capacity than on the actual property offered. This is no doubt true when an actual purchase is contemplated, but even then the actual tangible property and its physical condition enter into the general consideration. This question of the value of the physical property certainly is an important factor, in fact, the most important feature, where the "Improvements" account is to be drawn on to assist in placing a mortgage or in floating securities. The grouping of Maintenance of Way expenses should not be governed by the special views and methods possibly adopted by a possible purchaser of the property. We are dealing with facts and the present time when charging out accounts. Book-values should represent actual cost, assuming that the property is properly maintained or with certain allowances for depreciation, and not be subjected to the fluctuating conditions of trade, good or bad traffic years and stock market quotations.

If all absolutely New Work is considered as Additions, we need not be particularly afraid of the complications that might arise in future years from work having been so charged without being able to trace any direct subsequent results as a money-saver or money-maker. There is a much

more serious question affecting the reliability of book-values, namely, that in the run of years structures may depreciate from want of proper maintenance or more particularly become antiquated in comparison with the progress in railroad methods, and hence of less actual value at such time than the original book-value. This would be of serious moment if the Capital Account were directly involved, and would call for periodical writing off of book-values to cover the progressive depreciation from this cause.

As above stated, however, in the present investigation it would seem more particularly desirable to obtain a proper rule, so as to group and classify separately in the general Operating Account such items of the Maintenance of Way expenses which render it impossible to make a fair analysis and comparison of the actual running expenses of the road. In such case the definition desired applies more to the present time and not so much as to its effect on the future. Even if the question of possibly charging these items to Capital Account is to be considered, the view is correct that the expenses for New Work at the time incurred will generally tend to raise the value of the property at such time, and therefore could be, if desired, charged to Capital at such time, the general understanding being that such new property would be properly maintained, and if found necessary in the run of years to remodel or improve same, then such additional expense would have to be taken care of as part of the Operating Expense in future years so as to keep the property from depreciating.

There is one additional question to consider in connection with charging all new work as "Additions" to the property. While all general rulings governing accounting should, in theory, be independent of the amount of the charge, there is a question whether the strict ruling might not bring in a mass of small, insignificant jobs and cause the "Additions" and "Improvements" accounts to be discredited as a means of critical analysis and proper ultimate disposition of such expenses. Thus, a new crossover between two tracks where none previously existed, a new switch protection signal, a new flagman's shanty, are all New Work in the strictest sense. It would seem desirable that there should be some distinction as to what constitutes New Work or "Additions" to the property, so as to eliminate these smaller jobs. There seems to be no satisfactory method or definition to exclude this class of jobs, excepting to specify an arbitrary minimum limit below which no charges should be made to the "Improvements" account. Whether it is desirable to adopt a minimum limit, and what that limit shall be, is a matter of individual opinion. Personally, the views of the writer are that a limit is desirable, especially if the Improvement Account is possibly to be transferred some day to Capital Account, as the charges in such case would be of such a character as to be less liable to be questioned.

It has appeared desirable to analyze this question thoroughly as to whether all New Work necessarily constituted a proper charge as an "Addition" to "Improvements," so as to establish the reasons controlling the view taken that all important New Work is properly chargeable as

"Additions" to "Improvements," i. e., should be considered as raising the value of the property. We are dealing with the present, and the introduction of any new physical addition to the property, authorized after due consideration by the proper operating officers, must be considered as adding something tangible to the property at the present time and hence enhancing its value. The physical maintenance of this addition to the property and keeping it from becoming antiquated is a matter for disposition in subsequent years under expenses for current repairs and replacing or remodeling existing facilities in such years.

The principal classes of work in the Maintenance of Way Department that will come up for review as to their proper classification under the above rule for New Work being properly chargeable to "Additions," assuming in all cases that the work done is absolutely in connection with adding some new facility which in itself is a distinct separate improvement, will be as follows:

New passing sidings.
Extension of existing passing sidings.
New Second Track on single track road.
New Third and Fourth Track on double track road.
Extension of Branch Tracks.
New sidings to Industrial Plants, Mines, Factories, etc.
Extension of existing sidings at Industrial Plants, Mines, Factories, etc.
Extensions of existing sidings at Shops and Yards.
New Railroad and Highway Bridges.
New Turntables.
New Buildings, such as passenger stations, freight houses, shops, engine houses, etc.
New Structures, such as piers, coal pockets, storage grounds, storehouses, coaling stations, etc.
New Auxiliary Buildings and Appliances, such as dwelling houses, sand houses, tool houses, oil houses, car inspectors' houses, icehouses, switch shanties, flag shanties, stock yards, ash pits, track scales, drop pits, transfer cranes, hoists, snow fences, air-brake testing plants, crossing gates, etc.
New Interlocking Plants, signal systems, automatic signals, etc.
New telegraph pole and wire lines.
New water stations.

On the basis of the conclusions reached above, the following definition of "Additions" is proposed:

"Additions" to consist of any permanent addition to the existing property and facilities, constituting a distinct, separate, new, permanent, physical improvement, tending to increase the value of the railroad property as a whole, such as new roadbed, tracks, bridges, buildings, structures, or other auxiliary appliances and fixtures, etc.; provided, such addition

or improvement is not in the nature of repairing, renewing, replacing, changing or remodeling any existing facility.

In case a minimum limit is desired, add the words "and provided that the total cost of the work exceeds ——— dollars."

"B"—Definition of "Betterments."

The term "Betterments" is defined above briefly as "Increase in value due to permanent improvement of existing facilities."

The second class of expenses of the Maintenance of Way Department besides New Work or "Additions," possibly chargeable to "Improvements," consists of the group mentioned above as the second subdivision of the general question, viz.: "Betterments to existing facilities, where an existing track layout, structure, building, bridge, etc., is permanently improved by rebuilding, replacing or remodeling same."

The decisive element in this case is whether the value of the railroad as a whole will be permanently raised by the expenditure in question, and to what extent one or more of the four principal contributory causes enumerated above, as tending to increase the permanent value of the property, are present so as to allow the cost of the work, or a certain proportion of same, to be considered as an "Improvement" under the head of "Betterments."

The questions entering into consideration, in connection with each job of this group, are complex and liable to be variously judged according to the individual views of the operating officers passing upon same. The Accounting Department can and should define as accurately as possible the class and nature of items properly chargeable under the head of "Betterments."

Attention should be called to the peculiar feature of this group of expenditures, that, probably in practically all cases, the proper amount, if any, to charge as Betterments will have to be based on estimates or a division of the total expense, according to the conditions in each case. In other words, it is seldom that the actual total cost of any particular piece of work will be properly chargeable to "Betterments" as it stands on the books.

The first question to consider in detail is the relative importance and reliability to be placed on estimates and deductions as to the influence of one or more of the four contributory causes affecting the permanent value of the property. The grouping of these four elements to Direct and Indirect Causes, as explained more fully heretofore in this paper, seems to be very appropriate in the discussion of Betterments.

In regard to the Direct Causes, it can be assumed that the evidence of an increase in the tangible real property, due to rebuilding, replacing or remodeling on a large scale or improved design of some inferior or antiquated railroad structure, is practically in all cases self-evident, and the proof is right there in the structure or track layout itself. Similarly, the substitution of a more permanent or, so to say, indestructible class of materials in a structure, in place of rebuilding same on the old plan with more or less perishable material and of bad detail design, necessitating

periodical renewals or extensive overhauling and repairs, will certainly create a positive reduction of the yearly maintenance expense. In both of these cases there is something tangible to show on examination of the structure itself, as compared with the original design. Assuming that good judgment is displayed in authorizing the work and in the execution of same, the results, as far as the Direct Causes are concerned, will show for themselves, and it does not need an expert engineer or property appraiser to recognize the fact that an improvement has been made over the former inferior facilities. The fact that there is some increment of improvement and increase of value can seldom be disputed. The only question open for discussion is the degree or money value of such increment and the best method of estimating same.

The Indirect Causes, consisting of increase of earning capacity and decrease of operating expense, are based on prospective estimated results, which may or may not be realized in the future. The main aim in charging to "Improvements" is to do it so as to obtain an idea of the expenditures producing permanent increase in the value of the property, and not leave such value subject to serious fluctuations owing to a non-realization of anticipated results. In other words, all charges representing alleged increase of value based on what, for argument's sake, might be called "predicted results subject to proof" should be dropped. If a halt is not made in this direction, the scheme might with a certain amount of logic be carried to extremes and allow of capitalizing the expected increase of revenue or decrease of expenses, and changing the book-values accordingly.

It is necessary to consider carefully the proper status and reliability of these Indirect Causes, because many railroad men insist that the only correct evaluation of a railroad property must be based on "Net Earnings," and hence anything that affects these affects also the value of the property. This is largely true in case of an actual sale of the property, but the actual visible real property is of greater importance in many transactions, for instance, in mortgage matters. Nearly all expenses under consideration as possible "Betterments" are due to necessary improvements and changes of existing facilities, so as to keep abreast of the times and meet the trend of improvements in railroading. The fact that a certain improvement will probably cause more economical operation, or induce certain new business, will always be the guiding motive of an operating officer in recommending it. The Indirect Causes enter, therefore, into consideration in deciding to do the work, but the value of the real property cannot be changed in anticipation of favorable results. In many cases such work and changes have to be undertaken so as to maintain existing book-values, i. e., so as not to allow the existing property to deteriorate owing to antiquated and inferior facilities; but even in such case there is generally some physical addition to the property.

It is not plausible to believe that a prospective purchaser of the property would simply examine the "Net Earnings" and close the bargain without taking some account of the physical condition and existing facilities of the road. The appraisement of the tangible property of the

road, based on a schedule or inventory of its facilities, mileage, character of roadbed, tracks and structures, is important, and should be kept distinct from the question of its actual earning capacity. In considering "Betterments," the appraisement will be affected by the Direct Causes to such an extent as the new facilities are visibly an improvement over the old structures, while the effect of the Indirect Causes, if the original estimates and assumptions have been borne out in practice, will be reflected when the question of "Net Earnings" is under consideration.

The conclusion reached is that the value of anticipated increased earning capacity or decreased operating expense, as far as due to changes and improvements of existing facilities, i. e., Betterments, should be sought and will be realized in the increase of "Net Earnings" of the future, while the book-value of the property, as far as dependent on Betterments under "Improvements," should only be affected by the increase in the permanent value of visible, tangible real property.

If this conclusion is accepted, then the only question remaining is to arrive at some rule to gauge this increase in value, and for this purpose an enumeration is desirable of the more important classes of jobs that may come up for review under the head of Betterments. While general rulings may be established, the application of same in many cases will be governed by individual views or special conditions.

"Replacing timber bridges with steel or stone structures; replacing open floor short span bridges with solid ballast floor bridges; eliminating bridges or trestles by building stone or pipe culverts and filling in openings." The increased cost of the new structure over that of rebuilding with the inferior class of materials is a Betterment, as the maintenance expenses will be less and a safer structure provided.

"Replacing steel bridges or turntables with the same class of materials, but with increased strength." The necessity of this class of work is to allow heavier power to run. In this sense it is an expenditure to aid in reducing operating expenses. At the same time, however, there is a visible increase in actual value of the bridge or turntable, owing to the additional metal used; in other words, there is a visible addition of non-destructible material, hence a permanent addition to the value. In any appraisement of the property, the character and strength of the bridges is one of the important points considered. Hence the increased cost of the new structure, with the increased strength, over that of rebuilding for the same strength as the old structure, is a Betterment.

"Introduction of power at existing turntables, in place of turning by hand." This is in the nature of an Addition to the real property, and, if not connected with an existing facility, would be classed as New Work. It is properly a Betterment.

"Extensive rearrangement and remodeling of existing yards; extensive rearrangement of existing track connections." In case there is no material change of track mileage, this class of work does not give a direct increase in value, and hence is not properly a Betterment. If there is a considerable increase of track mileage in the new layout over the old one,

then the increased value of the additional mileage is chargeable as a Betterment.

"Rebuilding and extending existing interlocking and signal plants; additions to existing water stations of reservoirs, extra water tanks, etc.; improving existing telegraph pole and wire lines by adding extra cross-arms and heavier wires; rebuilding on a larger scale, and with a better grade of materials, buildings and structures of various kinds." In case the new facility is materially improved and enlarged over the original structure, so as to form a distinct and perfectly apparent improvement, then the increased cost of the new facility or the increased cost of the new facilities over that of replacing the old arrangement, can properly be considered a Betterment.

"Replacing, at an entirely new location, and on a larger scale and improved layout, existing buildings, structures and facilities of various kinds; extensions on a large scale of existing buildings, such as freight houses, coal pockets, shops, warehouses, terminal structures, etc." In these cases the increased cost of the new layout, in place of rebuilding the old structure, is properly chargeable as a Betterment. In fact, in many cases, the new plant or facility is of such a radically improved nature, and being at a new location, any existing rule would probably be broken and the improvement classed as New Work, and the entire cost or the increased cost over the old abandoned plant charged to Additions.

"Remodeling or changes of existing buildings, structures and facilities of various kinds, without removing the old structures or making any important extension." In this case there is clearly no material increase of value, and hence the work cannot be considered as a Betterment.

"Strengthening timber coal trestles and terminal structures for heavier cars." This class of work differs from the strengthening of steel bridges, in that the material added is usually of a perishable nature, and hence the maintenance of the property increased. This work cannot be considered as a Betterment.

"Grade corrections, lightening grades and removing sags; alignment corrections, lightening or eliminating bad curves." This class of work is done to reduce operating expenses, and in some cases to make a better riding track. In some instances the actual results accomplished are positive, such as eliminating a tonnage controlling point of a locomotive run. Generally speaking, however, there is no radically new property value created. If the changes are extensive, and a very important and marked improvement, the rule would no doubt be broken and the work classed as New Work and an Addition to the property. In other cases the increased cost of the improvement over the old abandoned section of the line would be classed as a Betterment. If the changes are not extensive, then the only point to consider is whether there is any increase in track mileage, and in such case the value of the additional trackage would be properly a Betterment. As a rule, however, the aim would be to shorten the line, if anything. As a general rule it would be proper to consider that work of this character is not a Betterment, unless it is very extensive, and in such case a special decision would be reached as to whether to class it as a

Betterment or as an Addition. In some cases alignment changes and grade corrections are so extensive as to warrant classing them as Construction. The Maintenance of Way Department would usually, however, not handle such extensive construction work.

"Stone Ballast." In many ways this could be properly considered as extraordinary repair work. On the other hand, it produces a reduction of maintenance expenses, and in any appraisement of the railroad property one of the first questions asked would be as to the amount of stone ballasted track, and values established accordingly. Hence it would seem proper to class the increased cost of stone ballast over the original inferior class of ballast as a Betterment. In the case of a pioneer road, pushed for hundreds of miles through an unsettled country and only dirt ballasted, it would be proper to charge the cost of furnishing regular ballast to Construction, i. e., Capital, even if such work was done years after the original nominal completion of the work.

"Renewal of Rails." The work of renewing rails is a regular recurrent annual operation, and is strictly a current repair job. It cannot be classed as a Betterment, as it is simply maintaining the property as fast as it depreciates annually from wear and tear. The only question open to discussion is whether the fact of introducing heavier pattern rails in place of light patterns is not a Betterment of the property. The heavier rails are called for by the heavier rolling stock, and have to be introduced to keep up with the best practice. On the other hand, the heavier rail reduces the cost of maintenance of the roadbed and track, although it does not seem to give any appreciable longer life to the rail itself. Further, in any appraisement of the property, the pattern of rail used is an important factor. This is one of those cases where individual views will largely govern. Some would consider that the cost of the increased material in the heavier pattern rail, over the lighter section replaced, should be charged as a Betterment. Personally, the writer considers that this increased cost of the heavier pattern rail should not be considered as a Betterment. This ruling would no doubt be broken in the case of a pioneer road, built originally in the cheapest manner possible with a very light rail, being practically rebuilt on an entirely new standard. In such case the increased weight of rails is an important element of the contemplated Improvements for which new money had been raised, and hence more properly a Betterment.

"Renewal of ties, switch timbers and bridge timbers." This material is of a perishable nature and requires constant periodical renewal, and hence should not be classed as a Betterment.

Finally, attention should be called to the desirability of excluding small, comparatively insignificant increases in value, and this can be done best by adopting a minimum charge limit.

On the basis of the above arguments and conclusions, the following definition of "Betterments" is proposed:

"Betterments" to consist of any permanent betterments to the existing property and facilities, constituting an actual, distinct, positive, permanent, physical improvement, tending to increase the value of the rail-

road property as a whole, the charge to cover in all cases only the difference in cost of the new improved structure or facility and the estimated cost of replacing the old unimproved structure or facility, the term Betterments to apply in general to work such as replacing bridges with a more permanent character of materials, strengthening bridges for increased loading, rebuilding buildings, structures, auxiliary appliances and facilities of various kinds on a larger scale and with a better class of materials, increase of track mileage due to rearrangement and remodeling of existing yards and track layouts, stone ballasting, etc.; provided, the work in question does not consist merely of extensive repairs or remodeling and changing of existing facilities producing no visible extension or important enlargement of such facilities.

In case a minimum limit is desired, add the words "and provided that the total difference in cost of the work properly chargeable under this head exceeds ——— dollars."

IV. SUBDIVISION OF MAINTENANCE OF WAY GROUPS OF EXPENSES.

It is well known that the official classification or ledger-accounts prescribed by the Interstate Commerce Commission for the subdivision of Operating Expenses under the head of "Maintenance of Way and Structures" is defective in many ways. The ledger-account, Repairs of Roadway, is too general and has to embrace too many classes of expenditures, while undue importance is given to other items for which separate accounts are prescribed; further, the expense for engineering and superintendence has to be distributed to a number of accounts and thereby the identity of the total cost of this class of charges lost. Railroads are forced to open sub-accounts under these various prescribed official ledger-accounts so as to get some tangible comparative value from the resulting figures, or else adopt certain ledger-accounts to be subsequently merged into the proper Interstate Commerce Commission accounts.

The inefficiency of these prescribed Interstate Commerce Commission ledger-accounts becomes more marked when Improvement work is handled by the regular Maintenance of Way organization. In such case, the "job" should become the leading feature. The general sub-grouping of "Improvements" should be based on the classes of jobs, such as passing sidings, industrial sidings, yards, bridges, coaling and water stations, interlocking plants and signals, passenger and freight stations, etc. The subdivision of the "job-account" should give the expense of the principal classes of work performed, such as grading, masonry, bridges, track, buildings, etc. In other words, the subdivisions of the expense of Improvement work should be made on the basis of the engineering or Construction groups, and not on the basis of the regular maintenance ledger-accounts.

With reference to the proposed general grouping of Maintenance of Way expenses to "Repairs," under four sub-groups, and to "Improvements," under two sub-groups, it can be stated that the prescribed ten

ledger-accounts of the Interstate Commerce Commission, if properly subdivided into sub-accounts for each ledger-account, will give fairly good comparative results for all items classed as "Repairs," but of not much practical value for the jobs classed as "Improvements," for which latter an engineering or Construction subdivision would be preferable.

There are two methods pursued by the railroads of this country, as follows:

1st Method.—The prescribed official classification of the Interstate Commerce Commission is followed strictly, and hence the proper subdivision for the proposed six sub-groups of Maintenance of Way expenses would be the adoption of the ten ledger-accounts prescribed by the Interstate Commerce Commission, as follows:

1. Repairs of Roadway.
2. Renewal of Rails.
3. Renewal of Ties.
4. Repairs and Renewals of Bridges and Culverts.
5. Repairs and Renewals of Fences, Road Crossings, Signs and Cattle Guards.
6. Repairs and Renewals of Buildings and Fixtures.
7. Repairs and Renewals of Docks and Wharves.
8. Repairs and Renewals of Telegraph.
9. Stationery and Printing.
10. Other Expenses.

It is desirable to have engineering and superintendence kept as a distinct account, and hence a special ledger-account is frequently opened to cover it. In making a return to the Interstate Commerce Commission this account is then distributed according to the rules to the regular accounts. There are several methods for handling this account so as to preserve its identity, and yet merge it ultimately in the ten regular accounts.

For the sub-groups of "Additions" and "Betterments," comprising collectively "Improvements," the same ten ledger-accounts would have to be used, but the headings might be varied, so as to correspond better to the character of the work performed, as follows:

1. Roadway.
2. Rails.
3. Ties.
4. Bridges and Culverts.
5. Fences, Road Crossings, Signs and Cattle-Guards.
6. Buildings and Fixtures.
7. Docks and Wharves.
8. Telegraph.
9. Stationery and Printing.
10. Other Expenses.

Suitable sub-accounts should be opened under each ledger-account so as to obtain the necessary division for better and more valuable com

parative statistical data. These sub-accounts should be preferably the same for each ledger-account throughout the six sub-groups of expenses, although the sub-accounts could be the same for the four sub-groups embraced under the general term "Repairs" and different again for "Improvements." Further, "job-accounts" should be opened, more particularly for "Improvements," and a separate summary report of same made giving the division of the expense to the several sub-groups.

Second Method.—A number of ledger-accounts are prescribed, generally without any sub-accounts. These ledger-accounts are then merged ultimately in making a report for the Interstate Commerce Commission into the ten regular official accounts according to a prescribed rule or key.

The rules of the Southern Pacific Railway Company, issued in 1898, for the classification of Maintenance of Way Expenses, call for 36 Railroad Company's Ledger-Accounts, 10 Interstate Commerce Commission Accounts, and 9 Annual Report Accounts, the Railroad Company's Accounts being merged into the other accounts as per prescribed rules. The revised rules of the same company, issued in 1902, prescribe 15 Maintenance of Way Ledger-Accounts, which are subsequently merged into the 10 Interstate Commerce Commission Acounts.

On the New York Central & Hudson River Railroad there are 31 Ledger-Accounts, which are subsequently merged into the Interstate Commerce Commission Accounts. Similarly, there are 25 Ledger-Accounts on the Pennsylvania Railroad.

The proper ledger-accounts to adopt is a detail matter which can be satisfactorily worked out, as it is independent of the classification of expenses as herein proposed to various sub-groups.

The fundamental principle advanced in this paper is that the Maintenance of Way expenses should be grouped primarily in two general groups, respectively, "Repairs" and "Improvements," and that the charges of each general group would be distributed to certain sub-groups; further, that each sub-group should be subdivided into either the ten officially prescribed ledger-accounts of the Interstate Commerce Commission, or into such ledger-accounts as thought desirable to adopt; and that each ledger-account can be composed of additional sub-accounts if desired. In this way, the present system in use on any railroad is not disturbed, as the regular prescribed ledger-accounts are preserved and the summary sheet of all the groups will give the total Maintenance of Way Expense properly subdivided to these regular ledger-accounts. Further, there should be a special statement of job-accounts and such additional statements as to provide comparative data and summary of expenses from month to month during each fiscal year, with information as to the estimated expense for the balance of the year.

The proposed system will offer the great advantage over the present practice in that it will give directly on the books, as a component part of the regular accounting system, valuable distinctions and sub-classifications of actual practical value. The analytical statistical method of comparing expenses, which is of such great importance in analyzing railroad

expenditures, relies for its basis on a proper subdivision and differentiation of the accounts. To make this differentiation positive and part of the regular accounting system, it is necessary to adopt a larger number of sub-groups with suitable subdivisions, as herein proposed. In addition, it forces all the officers, from the Division Engineer up, to take cognizance of the comparative data, and serves as a constant check on the expenses. While there is extra clerical work attached to the preparation of figures for six sub-groups and the summary statements of Maintenance of Way expenses, the work, when the system has been started, is mere routine clerical labor from month to month. The results, however, will be positive and of great value. The extra labor involved will, in the writer's opinion, be less than the time taken and disturbance caused under present methods, whenever information is called for suddenly as to reasons for certain increases in expenses, explanations or desired groupings of expense, so as to show more clearly the necessity for same, etc. Most roads have two groups, some three or more. It does not seem a great step to make the system more perfect and radical and adopt the six recommended groups.

On one prominent Eastern road a system with three groups has worked successfully for a number of years, but its main defects are that the one repair account is too big and requires subdivisions, while the second account embraces Extraordinary Repairs and Betterments, rendering distinctions difficult.

That a better subdivision of the accounts is desirable is probably not necessary to be further elucidated, and it certainly seems clear that the adoption of the six groups, as proposed, with close adherence in their subdivision to the Interstate Commerce Commission official classifications (or subdivided to such ledger-accounts as thought desirable, to be subsequently merged into the official classification), supplemented by such sub-accounts as desired, will not upset existing methods, but simply introduce a more practical division and grouping of same. The resulting accounting system will be uniform throughout and on a practical basis, giving detail and general grouping of expenses sufficient to answer most questions, and in such shape that special statements or merging of accounts, ex-parte statements, including or excluding certain items, etc., will not prove necessary so as to allow comparative data of value to be furnished or Improvement expenses to be shown separately for such disposition in the general financial statements of the company as may be ultimately determined.

V.—M.-W. ORDERS OR AUTHORIZATION FOR SPECIAL WORK.

It is self-evident that the subordinate officers of the Maintenance of Way Department, more particularly the men in charge of divisional work, are expected to proceed at all times without special orders, and keep the track and structures safe for the traffic and make such ordinary current repairs as absolutely necessary.

When, however, the repairs are of a more extensive character, not of an emergency character requiring immediate or constant attention, or special work of all kinds is called for, or large renewals or improvements

contemplated, it is necessary for such questions to be referred to the superior officers for consideration and issuance of suitable M. W. Orders authorizing the necessary expenditures.

On some roads the Order system is driven to extremes, separate blanks being provided for passing the Order down along the line even to the gang foreman, and other blanks reporting the work completed are returned up along the line. The writer's opinion is that where the Order system is extended so as to cover every little repair job, it becomes cumbersome and is not rigidly adhered to. Work is started on verbal orders and at the end of the month there is a scurrying in the office to get the M. W. Orders and postal card notices fixed up so as to pass inspection according to the rules.

The essential feature to cover is that special and irregular work, which might be postponed if the financial condition of the company did not warrant it, must not be started without special M. W. Orders. Further, such specific Orders serve as an official notice and assist the Auditing Department in checking and passing the accounts properly.

Adopting the six sub-groups for M. W. Expenses recommended above, it would not be correct to limit the "Current Repairs" and "Contingent Repairs" by requiring special Orders. The superior officers are expected to be in touch with the work through their various subordinates and to guide the work accordingly.

The class of work embraced under "Special Repairs" should be made subject to orders either by letter or special M. W. Order, issued by the officer immediately ranking over the division officers, say, according to the organization system of the road, the Engineer Maintenance of Way, the Principal Assistant Engineer, or the General Superintendent. The authorizing officer would naturally keep his superior advised at all times of all M. W. Orders issued for such "Special Repairs" and in important matters obtain verbal or written authority to issue such M. W. Orders. On some roads it may be thought unnecessary to issue M. W. Orders for "Special Repairs."

"Extraordinary Repairs" should in all cases be authorized by a special M. W. Order, to be issued by the highest officer of the Maintenance of Way Department, or even by the General Manager.

"Improvements" should be authorized by a special M. W. Order issued by the General Manager, Vice-President or President, dependent on the organization or size of the road.

Similarly, to follow out the system, "Construction" should be authorized only by a Vice-President or the President.

In establishing a system of M. W. Orders for special work of the Maintenance of Way Department, there are two leading elements to consider in deciding which officer shall finally authorize the work under the Order. One element is the class of work to be performed, and the other the amount of the expenditure.

Under the proposed general grouping of expenses, the writer does not consider that M. W. Orders should be issued for "Current Repairs"

and for "Contingent Repairs." Whether to issue M. W. Orders for "Special Repairs" is optional, but in all cases M. W. Orders should be issued for "Extraordinary Repairs" and for "Improvements."

One method would be to have three sets of M. W. Orders, to be used respectively for "Special Repairs," "Extraordinary Repairs" and "Improvements," the regulations and the blanks indicating which officer should finally authorize the work specified on the blank. This would, however, cause confusion, as some of the Orders might cover work chargeable to other groups than the one under which the Order is issued. Another method would be to have special M. W. Orders for the various officers, to be known, for instance, as "President's M. W. Order," "General Manager's M. W. Order," "Engineer's M. W. Order," etc., and defining the use of the orders by a money limitation or other rules.

The writer's recommendation would be that "Special Repairs" should be authorized by letter, or preferably by an M. W. Order, to be issued, say, by the Engineer Maintenance of Way, and to be known as an "E. M. W. Order." Every road should have in all cases, however, two special M. W. Order forms, one for "Extraordinary Repairs" and one for "Improvements." "Extraordinary Repairs" would be authorized, say, by the General Manager on a "G. M. Order," and "Improvements" would be authorized, say, by the President on a "P. Order."

All blanks for M. W. Orders would be filled out by the Division Engineer and passed up along the line to the authorizing officer, say the General Manager for "Extraordinary Repairs," and the President for "Improvements." After being duly authorized, the subordinate officer would be informed accordingly and the original M. W. Order transmitted to the Auditing Department as their authority for passing and checking the expenditure.

All M. W. Orders should indicate the division of the estimated expense as between the various groups of charges, such as "Additions," "Betterments," "Extraordinary Repairs," etc. As the actual final cost will vary probably in all cases from the estimated expense or amount of the Order, it would seem best to indicate the proposed division of expense on the M. W. Order by mentioning the percentages of the actual cost to be charged to the various groups, where the work done under the Order covers more than one group. In this case, the expenses as incurred each month would be charged out to the various groups in accordance with the percentages noted on the Order. The approval of the Order, with notation on same as to the expense groups to which the expenditures should be charged, would thereby establish the proper disposition of the charges in the accounts, starting with the originating Division Engineer's office and passing along through the various offices to the Auditing Department. In case of a change in the division being subsequently decided on or the actual cost of the various elements would be found to vary materially from the original estimate, then a change of the division of the expense would be duly authorized and the accounts straightened out.

That the system can be practically carried through successfully and

without complications is evidenced from the results obtained with a similar system in use for a number of years on a prominent Eastern railroad.

VI.—CONCLUSIONS AND BRIEF OUTLINE OF PROPOSED DEFINITIONS AND SYSTEM FOR MAINTENANCE OF WAY ACCOUNTS.

1. GENERAL.

The fundamental principle or system advocated in this discussion of the definition and grouping of Railroad Maintenance of Way accounts is that the Maintenance of Way expenses should be grouped in two general groups, "Repairs" and "Improvements," distributed to six separate sub-groups of charges; that each such sub-group should be subdivided into the ten officially prescribed ledger-accounts of the Interstate Commerce Commission, or into such number of ledger-accounts as each company may decide; that each such ledger-account can be composed of such sub-accounts as thought desirable.

Further, that summary reports should be made showing the six separate groups and a summary statement showing the total expense of the department. Each statement would be subdivided to the prescribed ledger-accounts, with such additional subdivisions of these various ledger-accounts as thought desirable. There would also be statements, in addition to the ledger-accounts, giving a summary by the principal classes of work or jobs; also comparative statements and summaries showing the total expenses from month to month during the year, with forecast as to the probable additional expense for the balance of the fiscal year, as far as thought desirable for each group.

"Improvements" and "Extraordinary Repairs," and preferably also "Special Repairs," to be authorized by separate M. W. Orders, the original M. W. Order to be sent to the Auditing Department as their authority for passing the expenditures, the M. W. Order to show the division of the expense to the several groups of charges by indicating the percentage chargeable to each group.

2. PROPOSED GROUPING.

The expenses of the Maintenance of Way Department (exclusive of charges direct to "Construction") should be grouped to two general groups and six sub-groups, as follows:

"R"—Repairs:—
- "A"—Current Repairs.
- "B"—Contingent Repairs.
- "C"—Special Repairs.
- "D"—Extraordinary Repairs.

"I"—Improvements:—
- "E"—Betterments.
- "F"—Additions.

3. PROPOSED DEFINITIONS.

The following definitions are proposed to cover the various groups of work:

The term *"Repairs"* to represent all expenses for the regular main-

tenance of the property, subdivided to four sub-groups, as per the following rules:

"Current Repairs" to consist of regular, constant, annually recurrent expenditures for repairs and sundry minor work, required regularly from year to year to maintain in an economical and efficient manner the physical condition of the property and keep the track and structures in shape and safe for operation, embracing all charges for superintendence, labor, materials and sundry items, in the nature of fixed expenses, regular forces, or customary material purchases, necessarily required for the regular maintenance of the property and the safety of the track and structures; provided, such charges are not in the nature of large expenditures incurred for unusual, unforeseen contingencies, for large special requirements not distinctly repair work or not uniform on all sections of a road, or for extensive non-annually recurrent repairs or renewals.

"Contingent Repairs" to consist of unusual, unforeseen expenditures, due to severe storms, floods, fire, accidents and casualties of all kinds, necessitating expensive emergency work and, in many cases, subsequent extensive repairs or renewals; provided, such work is not of such a comparatively small nature as to belong properly to the uniform and routine work of the regular Maintenance of Way forces, even if the expense is caused by an unforeseen contingency.

"Special Repairs" to consist of such minor items, necessarily permanently chargeable to Maintenance Account, even if not distinctly repair work, which items, if charged to Current Repairs, would tend to vitiate the comparative statistical value of the Current Repairs Account, or which items are too small and the work too insignificant to warrant charging to Extraordinary Repairs or classing as a permanent Improvement of the property.

"Extraordinary Repairs" to consist of large non-annually recurrent repairs or extensive renewals in the nature of maintaining the property; provided, such work does not constitute a Betterment or Addition.

The term *"Improvement"* to represent all expenses which create a specific, permanent, physical improvement, tending to increase the value of the railroad property as a whole, in the form of a Betterment or an Addition to the property, subdivided to two groups as per the following rules:

"Betterments" to consist of any permanent Betterments to the existing property and facilities, constituting an actual, distinct, positive, permanent, physical improvement, tending to increase the value of the railroad property as a whole, the charge to cover in all cases only the difference in cost of the new improved structure or facility and the estimated cost of replacing the old unimproved structure or facility, the term Betterments to apply in general to work such as replacing bridges with a more permanent character of materials, strengthening bridges for increased loading, rebuilding buildings, structures, auxiliary appliances and facilities of various kinds on a larger scale and with a better class of materials, increase of track mileage due to rearrangement and remodeling of existing yards and track layouts, stone ballasting, etc.; provided, the work

in question does not consist merely of extensive repairs or remodeling and changing of existing facilities, producing no visible extension or important enlargement of such facilities.

"Additions" to consist of any permanent addition to the existing property and facilities, constituting a distinct, separate, new, permanent, physical improvement, tending to increase the value of the railroad property as a whole, such as new roadbed, tracks, bridges, buildings, structures, or other auxiliary appliances and fixtures, etc.; provided, such addition or improvement is not in the nature of repairing, renewing, replacing, changing or remodeling any existing facility.

4. PROPOSED FORMS.

A number of tentative blank forms are submitted herewith as an illustration of the method of carrying out the proposed system. There are five Comptroller's Summary forms giving all the information required by the Auditing Department (outside of the usual vouchers, expense bills, payrolls, etc.) ; in addition there are six M. W. Department forms for the purpose of obtaining comparative data and keeping track of expenses from month to month, with forecasts for total expense for fiscal year.

A. B. & C. R. R. M. W. Form 500.

Maintenance of Way Expenses, ---------- Division

CLASSIFICATION OF CHARGES FOR CURRENT REPAIRS

For Month of ---------- 190 .

Classification	Labor	Materials	Sundry		Total
Total,					

Approved. Approved. Correct

Engineer Maintenance of Way | Division Superintendent | Division Engineer

A. B. & C. R. R. M. W. Form 501.

Maintenance of Way Expenses, ... Division

CLASSIFICATION OF CHARGES FOR CONTINGENT REPAIRS

For Month of ..... 190 .

Cause	Date	Locality	Designation of Work		Total Expended during Month
			Total,		

SUMMARY SHOWING CAUSES

Snow Storms	Wind Storms	Flood	Fire	Derailments	Land Slide
Mine Settlement	Sundry				Total

Approved: ..... Engineer Maintenance of Way.

Approved: ..... Division Superintendent.

Correct: ..... Division Engineer

A. B. & C. R. R

M.W. Form 503.

Maintenance of Way Expenses, ---------- Division

STATEMENT OF EXPENDITURES FOR CONTINGENT REPAIRS.

For Fiscal Year 190 . Report for Month of ---------- 190 .

Cause	Date	Designation of Work	Expended during Fiscal Year to Beginning of Month	Expended during Month	Total Expended during Fiscal Year to End of Month	Estimated Amount Required during Balance of Fiscal Year for Work in Sight
		Total,				

Cause	Expended during Fiscal Year to Beginning of Month	Expended during Month	Total Expended during Fiscal Year to End of Month	Estimated Amount Required during Balance of Fiscal Year		Estimated Total Expenses for Fiscal Year
				For Work in Sight	For Possible Additional Expenses	
Snow Storm						
Wind Storm						
Flood						
Fire						
Derailment						
Land Slide						
Mine Settlement						
Sundry						
Total,						

Approved: Approved: Correct:

---------- ---------- ----------

Engineer Maintenance of Way. Division Superintendent. Division Engineer.

A. B. & C R R. M.W. Form 502.

Maintenance of Way Expenses, ---------- Division

STATEMENT OF EXPENDITURES FOR CURRENT REPAIRS

For Fiscal Year 190 . Report for Month of ---------- 190 .

Designation of Work	Expended during Fiscal Year to Beginning of Month	Expended during Month	Total Expended during Fiscal Year to end of Month	Estimated Amount Required for Balance of Year	Estimated Total Expenses for Fiscal Year
Total,					

Approved: Approved: Correct

Engineer Maintenance of Way Division Superintendent Division Engineer

A. B. & C R. R. M.W. Form 504

Maintenance of Way Expenses, ---------- Division.

STATEMENT OF EXPENDITURES ON ..... M.W. ORDERS.

For Fiscal Year 190 . Report for Month of 190

Order No	Designation of Work	Total Amount of Order	Expended During Fiscal Year to Beginning of Month	Expended During Month	Total Expended During Fiscal Year to End of Month	Estimated Amount Required for Balance of Year	Estimated Total Expenses For Fiscal Year
	TOTAL,						

Approved: Approved: Correct:

Engineer Maintenance of Way. Division Superintendent. Division Engineer.

NOTE This Form to be Used for M W Orders Issued by the President, General Manager or Engineer Maintenance of Way

M W Form 505

A B. & C. R. R.

Maintenance of Way Expenses, Division

COMPARATIVE SUMMARY OF EXPENDITURES.

Fiscal Year 190 . Month of.....190 .
Actual Expenditures for Month of.....190 .

Expense Group	Current Fiscal Year	Previous Fiscal Year	Increase	Decrease
Current Repairs				
Contingent Repairs				
Special Repairs				
Extraordinary Repairs				
Total Repairs				
Betterments				
Additions				
Total Improvements				
Total M.W Expense				

Actual Expenditures for.....Months of Fiscal Year 190 .

Expense Group	Current Fiscal Year	Previous Fiscal Year	Increase	Decrease
Current Repairs				
Contingent Repairs				
Special Repairs				
Extraordinary Repairs				
Total Repairs				
Betterments				
Additions				
Total Improvements				
Total M.W. Expense				

Estimated Expenses for Balance of Fiscal Year 190
for Balance of.....Months .

Expense Group	Estimated for Current Fiscal Year	Actual for Previous Fiscal Year	Increase	Decrease
Current Repairs				
Contingent Repairs				
Special Repairs				
Extraordinary Repairs				
Total Repairs				
Betterments				
Additions				
Total Improvements				
Total M.W. Expense				

Estimated Total Expenses for Fiscal Year 190
For 12 Months ending June 30th, 190 .

Expense Group	Estimated For Current Fiscal Year	Actual for Previous Fiscal Year	Increase	Decrease
Current Repairs				
Contingent Repairs				
Special Repairs				
Extraordinary Repairs				
Total Repairs				
Betterments				
Additions				
Total Improvements				
Total M.W Expense				

Approved: Approved: Correct:

Engineer Maintenance of Way Division Superintendent. Division Engineer

A. B. & C. R. R. — Comp. Form 1000.

Maintenance of Way Expenses, - Division

SUMMARY

For Month of- - - - - - - - - - - - - - - - 190

Ledger Account	R. Repairs	I. Improvements	Total M.W. Expense
Total,			

Approved: - - - - - - - - - - - - - - - - - - Engineer Maintenance of Way.

Approved: - - - - - - - - - - - - - - - - - - Division Superintendent

Correct: - - - - - - - - - - - - - - - - - - Division Engineer.

A. B. & C R. R. — Comp. Form 1000A.

Maintenance of Way Expenses, ... Division

REPAIRS

For Month of . . . . . 190 .

Ledger Account	A. Current Repairs	B. Contingent Repairs	C Special Repairs	D. Extraordinary Repairs	R. Total Repairs
Total,					

Approved - - - - - - - - - - - - - - - - - - Engineer Maintenance of Way

Approved - - - - - - - - - - - - - - - - - - Division Superintendent

Correct - - - - - - - - - - - - - - - - - - Division Engineer.

A. B. & C. R. R. Comp Form 1000B.

Maintenance of Way Expenses, ---------- Division

IMPROVEMENTS

For Month of ---------- 190

Ledger Account	E. Betterments	F. Additions	I. Total Improvements
Total,			

Approved: ---------- Engineer Maintenance of Way.

Approved: ---------- Division Superintendent

Correct: ---------- Division Engineer.

A. B. & C. R. R. Comp. Form 1001.

Maintenance of Way Expenses, ---------- Division

Classification of Charges on ---------- M. W. Orders.

For Month of ---------- 190.

Order No	Designation of Work	C. Special Repairs	D. Extraordinary Repairs	E. Betterments	F. Additions	Total
	Total,					

Approved ---------- Engineer Maintenance of Way

Approved ---------- Division Superintendent

Correct. ---------- Division Engineer

A. B & C. R. R. Comp. Form. 1002.

Maintenance of Way Expenses, ... 190

COMPARATIVE SUMMARY

Fiscal Year 190 . Month of 190

For Month of 190

Expense Group	Current Fiscal Year	Previous Fiscal Year	Increase	Decrease
Current Repairs				
Contingent Repairs				
Special Repairs				
Extraordinary Repairs				
Total Repairs				
Betterments				
Additions				
Total Improvements				
Total M. W. Expense				

For . . . . Months of Fiscal Year 190

Expense Group	Current Fiscal Year	Previous Fiscal Year	Increase	Decrease
Current Repairs				
Contingent Repairs				
Special Repairs				
Extraordinary Repairs				
Total Repairs				
Betterments				
Additions				
Total Improvements				
Total M W. Expense				

Approved . . . . . Approved . . . . . Correct . . . . .

Engineer Maintenance of Way. Division Superintendent. Division Engineer

5. RECOMMENDATIONS.

In order that the question of the proper definition and grouping of Maintenance of Way expenses and the working out of a practical accounting system should be handled in an authoritative and conclusive manner, so as to bring tangible results and influence the railroad companies to adopt the best and most practical system, thereby securing greater uniformity throughout the country, it would seem desirable for the American Railway Engineering and Maintenance of Way Association to appoint a special committee on this subject, with the idea that a report from such

a committee of representative and competent members, if subsequently adopted by the Association, would serve as the incentive to an Association of Accounting Officers or the American Railway Association to treat the subject further in a more authoritative and official manner.

The leading questions for such a committee to consider would be, in general, as follows:

Collection of data as to accounting systems in use on leading railroads.

Adoption of general principles.

Division of expenses in general groups (proposed, two general groups, "Repairs" and "Improvements").

Division of general groups in sub-groups (proposed, four sub-groups for "Repairs" and two sub-groups for "Improvements").

Adoption of terms for the several groups (proposed, "Repairs," subdivided to "Current Repairs," "Contingent Repairs," "Special Repairs" and "Extraordinary Repairs;" and "Improvements," subdivided to "Betterments" and "Additions").

Adoption of definitions for the various terms and groups, and examples of application.

Subdivision of each of the sub-groups to ledger-accounts, and list of desirable sub-accounts for each ledger-account.

Subdivision of each of the sub-groups to principal classes of work or method of reporting "job costs" and desirable subdivisions of same.

Office methods and forms for compiling and grouping expenses.

Report forms for reporting expenses to Auditing Department.

Report forms for comparative statistics and summary classification and analysis of various expense groups.

Desirability and method for authorizing special work.

Order forms for authorizing work.

BRIDGE INSPECTION METHODS.

Atchison, Topeka & Santa Fé, monthly by General Foreman, yearly by Superintendent and General Foreman.

Bangor & Aroostook, monthly and spring and fall regular by Superintendent Bridges and Buildings.

Bismarck, Washburn & Great Falls, monthly by Bridge Superintendent.

Boston & Maine, fall by Inspectors and Supervisors.

Burlington, Cedar Rapids & Northern, frequently by Division Foreman, annually by Division Engineer.

Chicago & Alton, quarterly by Engineer Maintenance of Way, semi-annually by Chief Engineer.

Chicago & Eastern Illinois, frequently by foreman, annually by Superintendent Bridges and Buildings and foreman.

Chicago & Northwestern, September and April by Division Engineer and Superintendent Bridges and Buildings.

Chicago, Burlington & Quincy, by Bridge Superintendent.

Cincinnati, New Orleans & Texas Pacific, monthly by Superintendent Bridges and Buildings, quarterly by Chief Engineer.

C., C., C. & St. L., frequently by supervisor, annually by Engineer Maintenance of Way.

Duluth & Iron Range, monthly by foreman, spring and fall by Superintendent Bridges and foreman.

Florence & Cripple Creek, monthly by supervisor.

Fremont, Elkhorn & Missouri Valley, annually by Division Engineer and Superintendent Bridges and Buildings.

Houston & Shreveport, semi-annually by Superintendent and General Superintendent.

Illinois Central, quarterly by Bridge Superintendent and foremen.

Intercolonial, annually by bridge inspector.

Jacksonville & St. Louis, monthly by bridge foreman.

Lake Erie & Detroit River, spring and fall by Engineer and bridge foreman.

Lake Shore & Michigan Southern, spring and fall by General Bridge Foreman and Principal Assistant Engineer.

Lehigh Valley, monthly by inspector, annually by Bridge Engineer.

Long Island, quarterly by bridge foreman, semi-annually by Superintendent Bridges and Buildings, annually by Engineer Maintenance of Way.

Louisville & Nashville, monthly by bridge foreman, quarterly by Bridge Superintendent, annually by Bridge Engineer.

Michigan Central, semi-annually by Assistant Bridge Engineer and foreman, annually by Bridge Engineer.

Missouri, Kansas & Texas, frequently by inspectors and foremen.

Nashville, Chattanooga & St. Louis, frequently by bridge foreman and supervisor, annually by Chief Engineer.

N. Y. C. & H. R. R. R., continually by inspectors, quarterly by supervisor.

Norfolk Southern, monthly by supervisor, March and September by Engineer Maintenance of Way.

Northern Pacific, January by Superintendent Bridges and Buildings, September by Division Engineer and Superintendent Bridges and Buildings.

Pecos Valley, semi-annually by General Foreman Bridges and Buildings and inspector.

Pennsylvania Lines West of Pittsburg, monthly by foreman, quarterly by Master Carpenter, annually by Engineer of Bridges.

Philadelphia & Reading, annually by Bridge Engineer and foreman.

Pittsburg & Lake Erie, frequently by foreman carpenter.

Santa Fé, Prescott & Phœnix, weekly by trackwalkers, semi-annually by Chief Engineer and general foreman.

Plant System, semi-annually by Superintendent Bridges.

Seaboard Air Line, spring and fall by Bridge Foreman and Roadmaster.

Southern Indiana, semi-annually by Engineer Maintenance of Way and Superintendent Bridges and Buildings.

Southern Pacific, quarterly by inspector, foreman, Resident Engineer, and Engineer Maintenance of Way.

Terre Haute & Indianapolis, spring and fall by Master Carpenter and Engineer Maintenance of Way.

Toledo, Peoria & Western, annually by Master Bridges and Buildings.

Union R. R. of Pittsburg, monthly by Master Carpenter, semi-annually by Engineer Maintenance of Way.

West Virginia Central & Pittsburg, spring and fall by Bridge Foreman and Engineer Maintenance of Way.

Wheeling & Lake Erie, continually by inspector, annually by Chief Engineer and Superintendent Bridges and Buildings.

Wisconsin Central, semi-annually by Division Engineer, Principal Assistant Engineer and General Foreman.

DISCUSSION.

*Mr. Hunter McDonald (Nashville, Chattanooga & St. Louis Railway—by letter) :—The report is exceptional in one respect. It reviews the work of previous committees, and, in doing so, emphasizes the fact that considerable matter has already been prepared for the Association by this Committee, upon which no definite action has been taken. It would seem advisable that the Committee in its future work should take up and secure action upon previous reports before preparing any new matter.

The reviewing of the year's work of the Committee is an excellent idea, and the adoption of this plan by other committees would be wise. The definitions submitted are rather longer than would appear necessary, but seem to cover successfully the meaning of the words as used by this Association.

The specifications do not appear to be properly drawn. They should be so prepared that they would be applicable only to the work of the printer and binder. They should not include the principles upon which the blanks are designed. Each blank should show on its face the particular specification for that blank, viz., class of paper, color, size, form, ruling and binding.

Much more matter seems to be treated under the historical head than appears to properly belong there. It would appear that the various forms of organization assumed by the Committee, to which the proposed blanks are made applicable, would properly fit that of the majority of roads in this country. The Committee leaves it to each company to decide how often reports should be made; to apply titles, such as daily or monthly, is, therefore, inconsistent. It would seem better for the Committee to give such names to the reports as it thinks best and state how and when they should be made.

Form M. W. 1000, Daily Report of Foreman of Bridges. A daily foreman's report does not appear to be necessary. Master Carpenters should keep themselves familiar with the work of the different foremen by visits, rather than by reports. It would seem necessary only to report to him when a gang has completed one piece of work and will move to another point or take up other work. Both Master Carpenter and Division Superintendent should be notified simultaneously of such movement. It seems to the writer that this form should be altered so as to be used only as a notification when the gang is moved from one point to another. It often happens that gangs are engaged on one piece of work several months, and again may be engaged on several pieces in one day. Monthly reports will supply the information necessary for record as to work done.

Form M. W. 1001, Bridge Material Report, provides for being made out by the foreman. Foremen in charge of gangs have no knowledge of

*Discussion of the fourth annual report.

— AMERICAN RAILWAY ENGINEERING & MAINTENANCE OF WAY ASS'N —

Master Carpenter's Report of Material, _____ Div., Month of _____ 19_____.

	Ft. B. M. Lumber @	@	@	@	@	Lin. Ft. Piling @	@	Wrought Iron LBS.	Cast Iron LBS.	Portland Cement BBLS.	Natural Cement BBLS.	Sand CU. YDS.	Crushed Stone CU. YDS.	Bld'g. Stone CU. YDS.	Culvert Pipe LIN. FT.	
On hand first of month.																
Received through Supply Dept.																
" from _____ Div'n																
" " _____ "																
Purchased on this Div'n.																
TOTAL																
USED IN REPAIRS.																
Renewal of Ties.																
Repair Bridges.																
" Culverts.																
" Fences etc.																
" Buildings.																
" Signals.																
" Docks & Wharfs.																
" Floating Equipment.																
Sent to _____ Div'n.																
" " _____ "																
-SPECIAL ACC'TS.-																
TOTAL																
Bal.- On hand at close of Mo.																

Approved:- _____ DIV'N. ENGR.

Correct:- _____ MASTER CARPENTER

any material except that delivered to them for each job on which they are at work. The Master Carpenter is the only person who can make such a report, and the form of it should be somewhat like the attached blank. On this blank it is assumed that the Master Carpenter has charge of masonry and culverts and carries some stock of material on hand at all times. Form 1002 gives the Master Carpenter full information as to material used. On some roads, where separate requisitions are required for all material for every different job of repairs and improvements, no material report is necessary, as charges are made directly on requisitions. This system does not appear either practicable or economical, and the monthly material report seems a necessity. The form has other defects, in that no provision is made for showing from what source material is received or to what point it is sent.

Form 1002, Foreman's Diary, is excellent, but it could be further improved if a column were added for a summary of the total amount of labor expended on each job, the total of this column to equal the pay-roll. The monthly expenditure on each job would be at once apparent.

Form 1003, Tool Reports, should have provision made in some way to show special tools received from or sent to some other gang or division.

Form 1004 should be made by the Master Carpenter only. It can readily be compiled from his office records and 1002. It will not often be needed if the form suggested above in place of 1002 is used. Provision is made for the report being sent in at stated periods. If used at all, it should be necessary only on completion of the work, as provided for in the report. The foreman can not always make this report, as two gangs often work on the same job.

The plan of reducing the work in the Master Carpenter's office is commendable, but it should be borne in mind that he is generally better equipped for clerical work than the foreman is. Foremen are rarely good clerks, especially after a hard day's work, and the Master Carpenter usually owes his advancement to his superior intelligence and education. His familiarity with the work qualifies him better than anyone else to "translate" the foreman's reports. Foremen should be relieved of all possible clerical work.

Requisitions made by Master Carpenter should either be in duplicate or in copying ink, so that impressions can be taken.

After keeping ledger accounts with each bridge for a number of years, the writer is of the opinion that it does not pay. It is not practicable to ascertain accurately all of the charges that should go to any one structure, unless the Auditor opens a special account therewith. A record of the physical condition and general history, including amounts of more important expenditures, is all that is necessary.

Form 1005, Bridge Inspector's Daily Report, seems to be intended to be made generally by the foreman. The last line of the instruction seems superfluous. It should be provided with a space to show action taken by Master Carpenter and Division Engineer. The office physical

record can be made up direct from these and the monthly report, Form 1006, is not needed.

M. W. 1007 would also seem superfluous, Form 1005 taking its place, the record being written directly. It would serve a good purpose in book form, in which both the Inspector and Master Carpenter would keep a record of inspections made.

The writer agrees generally with the Committee's idea of what office records should be, but it seems desirable that every opening counted as a bridge should have its sheet in its proper place in the record of a division, these sheets to be changed monthly as alterations are made, and full sets of blue prints kept on file in the Master Carpenter's office as well as in the office of the Division Engineer. There seems no necessity for a different sheet for different kinds of bridges, but attention is called to the fact that each span of important bridges is often differently treated, and this fact should not be overlooked in the preparation of blanks.

The Committee seems to have left out all reference to culvert records. It seems to be clearly within the province of this Committee to include culvert records in their scheme of blanks, since the Interstate Commerce classification combines them with bridges. Just when a culvert becomes a bridge has never been clearly settled, and it ought to be done by this Association, but the Master Carpenter should have supervision of culverts, as well as bridges. The forms should be so designed as to be applicable to bridges, trestles and culverts. The office record of culverts should be kept separate from that of bridges.

Mr. W. C. Cushing (Pennsylvania Lines—by letter) :—The report of the Committee, as presented at the last meeting of the Association, is admirable, and, while I do not wish to criticise it, I would like to offer a few comments, as the matter is of considerable importance.

The principle of the Committee, in which I fully believe, is to concentrate the clerical work in the office of the Engineer instead of in the office of the Master Carpenter. One of the best ways to do this is to adopt the daily system of bridge material report. This report is a blank on a letter-size sheet, 8x10½ in., and on it the foreman gives a list of material used at a particular structure during that day, mails it to the Master Carpenter for approval, who in turn forwards it to the Engineer. These are collected and entered in a proper record by the clerk in charge of that work, and afford all the necessary information for keeping an individual book account for each bridge or structure, which I consider invaluable. This report on a letter-size sheet will replace the Committee's blanks 1001 and 1002. I hardly consider Form No. 1000 as of any particular value, as the Master Carpenter is always in such close touch with his men that he is well acquainted with what is going on. It might be of use where the Master Carpenter had a very large territory in his charge.

Blank No. 1003, the bridge department tool report, should not be sent in oftener than once in three months. There is danger in too many reports, because in the hurry of every-day work they are not read. I have found, after long experience, that a tool report is one of the most neglected, and a checking up once in three months is ample.

The Committee's desire to have the Master Carpenter keep as few records as possible is very praiseworthy, but I notice that no provisions have been made for the Master Carpenter to obtain a record of the cost of his work. As he is frequently asked for estimates on the cost of certain work it becomes necessary for him to keep track of it, and, furthermore, it is advisable because it will lead him to additional economies. It was my practice to make up a statement of the cost of important work, after its completion, in complete detail, and furnish the Master Carpenter with a copy for his information.

Making copies of reports becomes very burdensome and expensive, and I think the Committee might have improved their suggestions by mentioning the use of reports printed on thin paper, so as to make as many copies as required, by the use of carbon paper. For instance, if the foreman writes up his daily report in duplicate, by the use of the carbon, the Master Carpenter can retain a copy for his information without any clerical work being required, until he has the articles summed up upon its completion. Many of the copies mentioned under the head of records on page 31 of the Committee's report can be taken care of in this way.

I am very much in favor of a storekeeper on railroads of any importance and size, a storeroom being located at the headquarters of the Master Carpenter. This storekeeper is then responsible for material shipped out and material returned, and greater care can be taken of the material than by having several stocks of material in the hands of different parties.

The idea of a structure report blank, No. 1004, is good, but it is incomplete in not having a space for the unit cost to be shown. To be of any value to him the Engineer must have his cost of work reduced to certain units, as in that way he is enabled to make quick estimates, that being the real object for keeping cost of work.

I fully agree with the Committee that the value of a ledger account with each bridge or structure is of the utmost importance and should not be neglected.

It does not seem to me that blank No. 1005, bridge inspector's daily report, is necessary, and I cannot conceive of the practicability of its use.

Mr. E. E. R. TRATMAN (Engineering News—by letter):—I have carefully read over the report of the Committee on Records, Reports and Accounts, and give below certain notes and comments upon the report, but I think it would be better discussed and criticised by those members who have to read, use and make reports of the kind dealt with in the report.

In the review of the work of the third committee and the suggestion that members of the Association should submit to the Committee questions which may arise in every-day practice, this is a good idea in theory, but in practice it never works. It is too indefinite, and few men will take the trouble to set forth the problems or difficulties which come before them for consideration of a technical committee.

In the daily report of Foreman of Bridges (Form M. W. 1000), I would suggest that the printed sentence read, "I have done the following

work to-day at the places noted." This would lead to a description of the location, as well as the character of the work.

In Form M. W. 1001, it is not quite clear what should be listed in the column headed "unit," and a heading more easily understood by the foreman might well be adopted.

In Form M. W. 1003, would it not be well to show the disposition made of tools, "broken or worn out," whether they are on hand, or have been shipped to the storehouse?

In regard to ledger accounts for individual bridges, these are undoubtedly of great importance, provided always that sufficient quantity and quality of help is employed to insure completeness and accuracy in the records. The matter of unit costs is of great importance, but in very many cases work is done and records are kept in such a way as to make it impractical to determine the unit costs with any degree of reliability.

Mr. JOHN D. ISAACS (Southern Pacific Company—by letter) :—I submit herewith a few notes upon the valuable report on Records, Reports and Accounts, being a somewhat desultory criticism thereon.

(d) Tool Reports: I perfectly agree with the Committee that it is better to have separate blanks for the two reports. In general it is unwise to combine material and labor reports, or any reports, which require prompt attention at some stated period in each month, with those that can just as conveniently be rendered at any time during the month, such as broken rails, ties removed from track, details of track work, which are generally wanted only for record purposes and to make up annual and semi-annual reports.

The objection to combining such reports with those required for use of Paymaster or Auditor, or other departments whose business necessitates reports at any particular time, is that it involves too much clerical labor within a limited time on the Carpenter Foreman or Roadmaster, and, in order to enable him to attend to his other duties, necessitates clerical assistance not otherwise needed.

I am rather in favor of considerable subdivision in reports, not only because it enables the official making them to distribute the work on them over the month, but it is more convenient for reference to the different classes of clerical employes in the general office for compilation, and is better for filing; furthermore, as a rule, all reports which should be made out by Carpenter Foreman and Bridge Foreman should be in such form as can be conveniently placed in the pocket, and should not contain too many different subjects, as this leads to too much brevity.

While on this subject it may not be improper to mention the fact that many reports are kept on all roads when their real use has long since ceased; for example, in the case of a new class of machinery, such as, for instance, a rock-crushing plant for ballast, or a wood-preserving plant for the treatment of ties. For the first few months the managing officer, in order to keep track of the output, the amount of supplies used, cost of operation, etc., so as to perfect the organization and management of the plant and put it upon a running basis, may require certain frequent reports to be made. The object of these reports once accomplished, a general

report at stated intervals of, say, once a month, is all that is necessary. In the beginning it is sometimes essential that daily telegraphic reports should be sent in. The practice once started, it is not unusual for daily reports, and even telegraphic reports, to be sent in for use when there is no further necessity for them, thus adding to the volume of files and the cost of telegraphing to a very unnecessary extent. In such cases my preference is for a temporary form of blank, either distinctly marked "temporary" or printed in small quantities, so that a fresh supply must be frequently ordered. This calls the attention of the officers to the temporary nature of such reports, and at frequent intervals suggests a discontinuance.

I have in mind a case in which telegraphic information involving not less than three hours a day of one expert telegrapher's time at the general office, possibly one hour a day at each division office, and more or less time at each station, was required and kept up with conscientious exactitude for thirty years, when it was discovered that this work had not only become useless to the company in question, but had been duplicated by much more complete and accurate observations of the United States government, to be had at any time, without cost, by those interested.

I would therefore suggest that forms of reports, except those involving information required by the Auditing and Paymaster's departments and certain standard matter, such as labor and material reports, accident reports, rail, tie, ballast, tool and condition of structure reports, be regarded as temporary and looked upon with suspicion at all times as being possibly no longer necessary.

While on the subject of telegraphing, I would say that much can be done to relieve this overworked branch of the service by the adoption in special cases of a temporary code for reports; for example, where the general officer in charge wishes to get daily progress reports of, say, rushed work on a trestle, he writes a letter to the division officer, to be transmitted to the foreman in charge of the work, about as follows:

CODE ON TRESTLE 286—SHASTA DIVISION.

Number of piles driven to date.....A
" " " past 24 hours.....B
Number of bents capped and braced to date.....C
" " " " past 24 hours.....D
Number of feet completed to date.....E
" " " past 24 hours.....F
Etc., etc., etc.

This is understood to apply only to the particular work in hand. The reports received at general office read something as follows:

TRESTLE 286.

A—150. C—20.
B— 40 D—15.
Etc., etc.

This is brief, less apt to certain mistakes in transmission, and is in every way more satisfactory than a lengthy dispatch on the same subject.

The code report expires by limitation with the completion of the particular job under consideration.

Organization: On large divisions, at all times doing considerable work, it is advisable to have in addition to the Master Carpenter, who really has charge of the gangs engaged in the actual work, some person whose business it is to see that the material ordered is received and on the ground ready for use of the gangs when they arrive at place of work. The Master Carpenter cannot very well do this, as much of his attention is taken up in seeing that various reports are correct, and that the work in progress is executed properly. There should be one assistant at least whose most important business it is to see personally that when a gang of men arrives at a point of work, the material is all on hand, or as much of it as will enable them to proceed continuously with the work, and it would be well to have the requisitions for material originate with this official. This involves an official in between the Foreman of Carpenters and Master Carpenter.

I believe a much superior system to that of having division records kept of material in stock or on hand is that of handling all material not in actual use by a general storekeeper. This prevents requisitions being ordered for material for one division which can be duplicated from the stock of another, thus diminishing the idle and unused material on hand. The division storekeeper's accounts should be as nearly as possible up to date at all times. While the proposed system of keeping up only a quarterly statement, even if such statements are carefully considered by the general office in making up requisitions for new material, would not be so satisfactory; for example, a statement of, say, piles on hand, January 1st, might not have to be referred to until February 1st or March 1st by a general officer wishing to have pile shipped from one division to another; in the meantime they may have been used on the first division, and, the quarterly statement not yet having come in, confusion and correspondence result.

In my opinion, one of the most useful forms of special reports is the Division Engineer's report of each completed structure. This report shows briefly the history of the structure brought up to date, cost of the original structure or structures, order number for and itemized cost of the finished or completed structure, photographs of the old structure and the new, diagram, such as is usually given in accounts of more important structures, giving depth of piles, masonry, borings, nature of foundations, and, in fact, a brief monograph of the structure for publication. These are made in duplicate, in foolscap size, bound in pamphlet form, and have a cover with a printed title. They are filed, one in the general office and one in the division office, so that at any time complete information concerning a given structure can be had, except mechanical details, etc., for which reference must be had to the drawings.

On the subject of bridge inspection, I beg to say that I think it best for this most important branch of the service to have a special official, reporting to the general office, and having as many assistants as may be necessary. This serves as a check upon the correct judgment of the division officer, and enables the general officer to get a great deal of

information as regards a particular structure by conversation with the man doing the inspection, so that special methods for falsework, erection, etc., may be considered by the general officer, without the necessity of going upon the ground with an official who is intimately acquainted with the structure itself. This portion of the service on our system has arisen to such importance that a General Bridge Inspector is really in charge of all important renewals, and is expected to make a study of modern methods, tools and appliances for the convenient and economical handling of the work of erection, repairs, etc.; usual repairs, however, are not attended to by the General Bridge Inspector.

I do not quite agree with the Committee that the unit cost of a structure is merely valuable and desirable, but I consider it essential for any system in which estimates and appropriations must be made before work can be undertaken, as the unit cost of executed work under conditions known to the general officers is about the only basis on which a correct estimate can be made.

I do not consider it advisable or necessary for a difference in color between blanks to be used by higher and lower grades of officials, but rather that a difference in color should be used to distinguish the different forms of blanks used by the same grades of officials. A difference in color is especially to be desired where one set of blanks is changed for any reason to another designed for a similar use; for instance, requirements under change of administration or change in form of bookkeeping may necessitate alterations in blanks. In such case a change should be made in color to prevent the use of old blanks or accidental reference to a wrong blank on file in the general office.

I am heartily in accord with the opinion expressed that the clerical work of the man actually in charge of work in the field should be reduced to a minimum. On all large systems there is a tendency on the part of the auditing or other clerical departments to inflict a multitude of reports upon a man whose chief duty it should be to manage his men and to use material as economically as possible. I am strongly opposed to a system which requires a piledriver foreman to be provided with a stenographer and a full-fledged office force, set of books, etc., to which his attention must be principally given, while the engineer of the driver bosses the gang when not engaged in talking politics with the conductor of the work train.

Mr. A. A. Wirth (Pennsylvania Lines—by letter) :—I have gone over carefully into the various blanks recommended by the Committee and beg to comment as follows:

Form M. W. 1000, Daily Report of Foreman of Bridges. Foremen, of course, are required to make daily reports of their whereabouts and what work they are doing. I do not think, however, a printed blank is necessary. Foremen should report the number of men that are at work, but the number of hours' work I do not think would be of any value.

Form M. W. 1001, Monthly Bridge Material Report. This report, if used at all, should not be made out by the foreman of bridges. Most divisions of any railroad have several bridge foremen, and no one of them

has the information to make out a monthly bridge material report for the division. If the report is desired, it should be made out by the Master Carpenter, and would be of no value unless each kind of material is itemized for each size. Instead of this report, the same information can be obtained in the office of the Division Engineer, who keeps a ledger account of the different material, obtaining his information as to that order from the structure report.

Form M. W. 1002, Foreman's Diary. I think this is also a useless blank. The foreman, on the completion of each job, makes up a structure report which embodies all the information contained in this diary. After the job is completed and the structure report sent in, I do not see that the possession of the information contained in this diary is of sufficient interest to the foremen to warrant the trouble of keeping it. If it is desired that the foreman keep a record of his daily work, a blank memorandum book of suitable size to carry in the pocket would be all that is required.

Form M. W. 1003, Daily Report. This is another report which I think is not needed. A good many carpenters own their own tools, which is the case on this division, the company only furnishing such heavy and bulky tools as cannot be conveniently owned by the carpenters themselves. The storekeeper keeps a record of tools sent out and received, which I think is all that is necessary.

Form M. W. 1004, Structure Report. This form is the most important one that the Foreman of Bridges makes out, and the form shown is very good. This report forms the basis of the charges and ledger entries pertaining to the bridge, and is then filed in the Division Engineer's office. The Committee, however, is wrong in saying that this report should be made in the Division Engineer's office; the idea, I presume, being to take the information from the daily report of the foreman to the monthly bridge material report. This report, however, should be made up by the foreman himself and sent to the Master Carpenter, who will check the same carefully, then forward to the Division Engineer, where it is filed, and the charges to the structure and the ledger entries are made.

There are three forms for bridge inspector's report, namely, 1005, 1006 and 1007. I think one is all that is necessary. The daily report is not needed. If the Master Carpenter or Inspector in making his periodical bridge inspections should come across anything which demands immediate attention, it should be brought to the notice of the proper parties by letter or wire. Otherwise the information is not of sufficient importance to warrant its use. Forms 1006 and 1007 seem to cover about the same ground and should be combined in one blank, which should be used by the Master Carpenter in making his periodical inspection. This blank should be more complete than what is shown in either one of the above-mentioned blanks, and should have mention made of the important members of the different kinds of structures, and the Master Carpenter should designate the condition of each of these members by certain marks. These inspections should not be the same as annual inspection made by the Division Engineer in company with the Master Carpenter, for the purpose of determining the general condition of the structures and the work

required to be done for next year. The best way to take these notes is to carry a good-sized notebook and write in fully the condition of the bridge and the recommendation for the next year's work. Afterward, in the office, these notes could be transcribed by the Engineer to a special blank used for this purpose alone. Exhibit C, showing blank used by the Southern Pacific Company, contains what I think ought to be used by the Master Carpenter's periodical inspections.

Exhibit D. The information contained in above should only be made up once a year, when it should accompany the annual report, and a copy should be kept in the office instead of single sheet, as shown. It is more convenient to forward and to file to have this information made up in pamphlet form, such as is used by this company in making annual reports.

Exhibit E. I think this would be a very valuable record to be kept in the office of the Division Engineer. It should contain the history of the structure and a full description of all its members, and a careful record of all repairs and alterations. It would show at a glance information which ordinarily is not obtainable at all on the division, or else which requires a long search from various other records.

J. P. Snow (Boston & Maine Railroad—by letter):—I desire to discuss only the latter part of the report, after the heading, "Bridge Inspection Report Blanks," on page 35 of Bulletin No. 34. As the Committee does not open the feature of rules and methods for the inspection of existing bridges, frequency of such inspection and other matters pertaining to this work, the following remarks will be confined as closely as possible to blank forms for reports and office records.

I object to the word "daily" in the Bridge Inspector's report. No one contemplates such reports from each bridge. The inspections should be made periodically, according to some rule, and each report should be dated, which shows what the inspector has done each day. I am in favor of a slip for each bridge, as recommended by the Committee, but disagree by thinking that a generous number of side headings should be printed on the blank. I find that my inspectors fail to note the condition of parts unless their attention is called to them by definite headings that are required to be reported upon by some answer. This omission is not due to lack of interest, for I find that I skip items myself when examining bridges, unless prompted by a list of requirements. Our systematic inspection has extended over several years, and I find that each time that I get a new stock of blanks, I increase the number of side headings. At first there were ten headings, now there are 26. Aside from the regular headings, which require but a single line or half a line each, there should be, preferably on the back of the report, headings for miscellaneous defects, changes since last report (referring to repairs or renewals) and recommendations, each to have several lines of space. These blanks are bound in cheap books of 100 blanks each, and perforated for detaching.

In answer to the statement on page 39, that too much time is required to fill in so extensive a lot of headings, I may say that our inspectors cover from 10 to 20 miles per day, which I think is as rapid work as

is compatible with proper examinations. In fact, all these features should be examined, or the work is slighted, and it takes simply no time to jot down "O. K." or "fair" or "poor" on its proper line after the examination has been made. If a sheet which is practically blank is furnished, the inspector must in effect write a heading for each part reported on, and hence, if the report is in any sense complete, he will do much more writing than if detail headings are printed on his form. A sweeping statement of "generally good" or "all right" is no inspection, in my opinion.

It is not advisable for the gang foreman to make these inspections and reports, as his time and thoughts should be occupied with planning work for his gang. There is no objection to these reports going through the hands of the foreman, and he should personally examine all that are reported poor, but this is very different from making periodical reports on hundreds of structures.

The blank should be of such size that it can be carried in the pocket, and as stub blanks for retention by the inspector make the book too large, our present practice is to use the same kind of blank for the inspector's use as for the report. Carbon paper may be used in the field with very little trouble, or the reports may be copied over while waiting for trains or during rainy weather.

These original reports should be sufficient for all parties concerned. They may go through the hands of the Master Carpenter, Superintendent, Division Engineer, Bridge Engineer and Chief Engineer if desired, and each can make such records from them as he needs, but it hardly seems necessary to summarize them as proposed by Forms 1006 and 1007.

I object to the word "monthly" on Form 1006 for much the same reason as given above against "daily" on 1005. The prescribed periodicity should be followed, but it may not accord very well with monthly.

If statements similar to Forms 1006 and 1007 are desired by any of the officers, they can be compiled by clerks from the original reports, and would be records simply, and not precisely reports. My preference is strongly for the report penciled on the ground by the man who makes the inspection. Any secondary report is less valuable, and if garbled, as it must be to fit the proposed forms, is very likely to be seriously injured by the editorial revision.

I see no use in repeating the location and kind of structure in successive reports, as is called for on Forms 1006 and 1007, nor similar fixed data on several of the sample inspection forms shown. An enterprising inspector would naturally fill out these items beforehand from office records or leave them until after his field work was done. Such filling in is clerical work, and it seems to me is wholly useless on an inspection report.

Office Records of Bridges: The office of final record should keep the Bridge Inspector's reports filed in such a manner as to be easily and surely available. Whether or not it is worth while to record these reports in a book is questionable. My practice is to do so, in large record books, in which a page or more is devoted to each structure, and a few lines

of description given at the top of the page showing kind of bridge, what it spans, its general dimensions, and strains in the principal parts. Below this follows the record of inspections, each line generally sufficing to enter the data from one examination. These books are paged with the bridge numbers, so that no index is needed. They show at a glance the data mentioned at top of page 40 of the Bulletin and also the successive reports of inspection. It is a fact, however, that, in my experience, I seldom refer to these books, and I think them hardly worth making up. I prefer to refer to the inspection slips themselves for a record of the examinations and to other records for the characteristics of the structure.

The records to which I constantly refer for information of all sorts concerning bridges are note books 5 in.x8 in., of 160 pages, containing descriptions of all openings, box and pipe culverts and highway, private and farm crossings in regular sequence, with approximate distance from nearest station, dates of building and repair, calculated unit strains, and such notes as may be jotted down at any time. These books are written in pencil, to facilitate corrections due to reconstruction, which in the aggregate are very considerable. These books can be taken into the field by the Bridge Engineer, but are not intended for the reception of field notes.

For the use of division and general officers and others needing a schedule of structures, typewritten lists are made for each division, giving number, location, kind of bridge, clear span, date of building and height from rail to ground or to floor of overhead bridges. This list covers all track and road bridges as well as box and pipe culverts.

In addition to the above, each Division Supervisor should have a pocket book with a separate page for each structure maintained by him, with a short description at top of page and notes of repairs or condition jotted down from time to time on the body of the page.

It appears to me that the forms shown by the Committee as exhibits E and F are too unwieldy for convenient use and too much in detail to be economically kept up to date. The working plans will show a large part of the data on exhibit F and the Auditor's accounts the rest. Exhibit D would seem to be useful merely for making up State and Interstate reports, and can be more conveniently recorded in separate books pertaining to track and other departments.

Any division between bridges and open culverts is purely arbitrary and conventional, and may be assumed at will by each person. The etymology of the words would confine "culvert" to a passageway that is covered over, either flat or arched, and "bridge" to whatever spans an opening. That is, the covered way is the culvert and the cover is the bridge. Common usage has made "culvert" mean the structure as well as the opening, and has also made it apply to open ways as well as covered.

I can see no economic reason for keeping a ledger account with individual bridges; hence it seems to me that the standpoint of "records, reports and accounts" is the same as that of maintenance. From a maintenance standpoint, I think that all structures where the track is supported by stringers, all those requiring ties different from the ordinary

track ties, and those which need painting periodically, as well as masonry arches, should be under the care of bridgemen rather than the section forces. There is no reason why all these structures should not be called bridges, and consequently I am in favor of limiting the word "culvert" to pipes, box culverts and those small openings between ties for carrying surface water from one side of the track to the other which require no stringers. All other structures carrying the track over openings I would call bridges.

I do not like the term "pipe-drain." A drain ordinarily implies a longer conduit than a passageway, open at both ends, under a track. Culverts must be classified as stone-box, wood-box, rail-covered, brick, iron, etc., and why not pipe-culverts? These latter must be again divided into cast iron, vitrified and cement.

The above classification leaves masonry arches rather indefinite. Arches exist of all spans down to two feet and perhaps less, but anything less than six feet may better be covered with stone slabs or rails in concrete, and I would name six feet as the limiting span of masonry arches that shall be classed as bridges.

I am aware that the scheme here proposed makes a very long bridge list for a given railroad, but all these structures need periodical inspection by other parties than the sectionmen, and if repairs are required other tools and material are needed than what the sectionmen have at hand.

Reports to State and National authorities must be based on whatever limits of span may be designated. The customary limit for these reports in New England is 10 ft. For New York it is 13 ft., and as the limit quite likely varies for other states, it cannot be taken as a distinctive division by which to define bridges in general.

I think the matter of accounts and records of expense is oftentimes overdone. The cost of work sufficient for making estimates on future work should, of course, be known, but this does not mean that full accounts of all work need be recorded. The detail of labor and material accounts must conform to the requirements of the auditing department, but it does not seem to me to be profitable to go farther than this, except for keeping a full knowledge of the material that is on hand.

Records should cover all features of the structure and its environment. Where plans have been made they should be obtained and placed on file. I have not found it necessary to make full drawings of bridges acquired by lease or otherwise of which no plans are in existence. Sufficient measurements are needed so that strains can be calculated. I find it best to make our record books of a size convenient to carry in the field and to write the data in pencil, so that corrections, to keep them up to date, can be conveniently made. Permanent records, like the reports of inspections, are made in ink and kept in the office.

The Committee finds it necessary, of course, to outline an organization before it can prescribe the working of the same. The prominence that the Committee gives to the Division Engineer is unusual in my experience, but

I think it would work with excellent results if the right men were engaged and the system thoroughly established.

If there is a Division Engineer, I agree with the report, that the clerical force of what we call the "road department" of the Division should be under his direction and that his records and office should be convenient and accessible to the Master Carpenter, the Roadmaster and the Division Superintendent and his subordinates. This office would be in direct communication with the General Auditor of Accounts and would furnish him with all data needed.

I think all reports, of every nature, should be so contrived as to need copying as little as possible. Summaries and results only should be transmitted to superior officers.

I agree with the Committee that ledger accounts with individual bridges are not worth what they cost, unless it be some structure whose maintenance is a joint affair. Too much distribution of accounts is needless and causes a serious addition to the clerical expense.

I believe office records should be available to take into the field. When I first had charge of these matters I thought that complete records of each structure could be put into large books in neat shape, devoting two or three pages to important structures, with outline diagrams of trusses, etc., showing computed strains and other data and leaving ample space for inspection notes and other current information. I soon found that we could not hope to execute any such plan, and I have since become convinced that we could never have kept such a scheme anywhere near up to date. Moreover, it would not have been consulted if it had been made. The books which I previously described, written in pencil, giving most of the data that we most frequently want, are consulted daily, are easily kept up to date, and can be taken along by the Bridge Engineer on inspection trips. Detail computation of strains is worked out in large books and consulted when strengthening or alterations are contemplated or when investigations as to maximum allowable train loads are made.

My ideal for an inspection system is for the trackmen to take daily notice of all bridges as they pass over them, and if anything unusual is seen, to report it to the Roadmaster, who should pass it over to the Master Carpenter. In addition, the Master Carpenter should detail a man who should make full periodical inspections, but he should put but a small part of his time to this, say an aggregate of two months each year. His reports should be vised by the Master Carpenter and eventually be lodged with the Chief Engineer. These reports should contain all data needed for keeping the office records up to date, and would hence be sufficient for making out State and Interstate reports, which I think should be made from the Chief Engineer's office rather than the Division Engineer's, as suggested.

In the statement under "Bridge Record Book," paragraph (a), I wish to say that the Northeast section of the country should be classed with the Southwest, as having a large number of bridges. Our region is hilly and covered with small streams, highways and farm roads as well as other features requiring structures over or under the track. The Bos-

ton & Maine Railroad has upwards of 3,900 which we inspect and keep record of, and ours is by no means a large system.

*Mr. HUNTER MCDONALD (Nashville, Chattanooga & St. Louis—by letter):—The Committee on Records, Reports and Accounts, in its last report, published in Bulletin No. 45, has refrained from making any recommendations as to bridge records, except that it has set out quite clearly the conditions which the blanks for such records shall fulfill.

The writer has for some years kept such records in bound books in connection with a detailed account of the cost of each bridge. This method being very unsatisfactory, he has sought another means of keeping the records, abandoning altogether the plan of keeping a monthly record of expenditures on each structure. The desirability of being able to duplicate any sheet of the record makes bound volumes unsuitable.

As culverts are kept up usually by the bridge department, and as their care is of equal importance to that of bridges, it is necessary that records of their condition be also preserved.

An attempt has been made to produce a single blank form which would be applicable to the records of bridges, trestles and culverts, but it has not been found possible, the requirements of each being so widely different.

Taking advantage of the suggestions of the Committee and considering the blanks which have been presented by it, the writer has prepared separate forms for records of bridges, trestles and culverts, which, while containing several defects which it seems impossible to remedy, fulfill the requirements as he sees them more nearly than any form which has yet been brought to his attention; they are submitted herewith.

The fact that different spans of bridges are often treated differently from the other spans on the same bridge requires that a separate record be kept of each span. The form for bridge records has been designed with this end in view. It is assumed that complete drawings, showing details, are on file in the proper office and readily accessible for minute details of construction. Provision has been made for periodical inspections and recommendations and a parallel column is provided for repairs, so that it can be seen at a glance what steps have been taken to carry out the recommendations made on the inspection. Provision has been made for a brief record of the history of both the superstructure and the masonry, and also for the paint record up to the time of filling out the blank; after that time the paint record will show for itself under the column for repairs. Small provision has been made for the bill of timber, as it is assumed that very little timber is required to be renewed on the modern railroad bridge. The writer does not agree with the Committee that trestle records are unimportant. There is, and will probably be for many years to come, an immense mileage of trestle work on the railroads of this country.

The form for trestle record is defective in that there is not much room for recording inspection and repairs; however, this can be remedied by the addition of a second sheet where necessary, which is ruled only for inspection and repairs. The space for the bill of timber is not large

*Discussion of 1904 report.

and in some instances would not be sufficient, and resort to second sheets might be necessary. It is proposed to show graphically on the profile and map a large amount of the information which, on the bridge sheet, is recorded in figures. It is not practicable to show by figures in so small a space, without a sketch, the superelevation, unless it is perfectly uniform across the structure. Easement curves often occur on trestle work, but seldom on truss bridges. The history and high water blanks are intended to record information which would bear on possibilities of filling in the future. It is supposed that trestles will be constructed in accordance with standard plans, and it is necessary to refer only to their class.

The culvert blank is intended to embrace anything from the ordinary pipe to the large arch, and the information to be recorded is such as the writer has found during his practice to be desirable.

All of the forms are one-fourth the size of an imperial sheet, so that there will be no waste. As suggested by the Committee, they are intended to be printed on bond paper, so that blue-prints can be readily made therefrom in order to make as many copies as necessary for the various officers.

It is intended to bind the forms for bridges and trestles together in the order of their sequence on the division. The numbering of bridges and trestles by miles and tenths from the initial point of the division lends itself readily to this arrangement. As the culverts are more numerous, they are to be bound separately, the system of numbering being similar to that of bridges and trestles, except that culverts should be numbered in miles and hundredths, and, in addition, the number of the telegraph pole nearest the culvert being given. The binding will be effected by means of the perforations shown near the top of each sheet.

The blanks have been designed for use on the system of which the writer has charge, and will probably contain many items of information not needed on other roads, and many items have no doubt been omitted which would be required by others. It is thought that the general form is one that will commend itself to the consideration of the members.

All ruling and printing should be in black, in order to facilitate blue-printing. The backs of the sheets should not be used for records.

Mr. Edwin F. Wendt (Chairman of Committee—by letter) :—The discussion of President McDonald of the general subject of Office Records of Bridges raises a question which did not receive a thorough study from the Committee, on account of a decision to defer the consideration of this subject to a fuure year. The Committee earnestly hopes that the members of the Association will submit many more discussions of this same subject.

On pages 51 to 60 will be found the discussion of this subject by the Committee, and on page 14, under Conclusion No. 4, will be found the position of the Committee, which is that greater study should be given by the Committee to the subject of Bridge Office Records before any final conclusion is formulated for submission to the Association.

President McDonald has taken up the question of trestle records, and states that he does not agree with the Committee that these records are

A. B. & C. R. R.

OFFICE OF CHIEF ENGINEER

*Record of Bridge No.*_____ *Span No.*_____

_____ *Division.*

Drawing Nos. ____ *Name*_____

Corr. File Nos. ____ _____ *N. or E. of*

*Survey Sta. No.*____ _____ *Station.*

Lengths in Feet.

*N. or E. Approach*____

*Bridge*____ *Spans*____

*S. or W. Approach*____

*Total,*____

PHYSICAL DATA	INSPECTION DATE	INSPECT	CONDITION	REPAIRS DATE	WORK DONE
Kind of Span					
Length "C to C" End Pins or Bearing					
" End to End					
Specifications					
Max Safe Engine Load (Tons)					
Depth of Truss or Girder					
No of Panels					
Length of Panels					
Width "C to C" of Truss or Girder					
Clearance					
Dist. Base Rail to Bridge Seat N. or E. End					
" " " " " " S. or W.					
" " " " Bed of Stream					
" " " " Bottom of Masonry N.or E.					
" " " " " " S.or W.					
" " " " High Water					
" " " " Low Water					
Weight of Metal in Pounds					
Cost Per Pound Erected					
Kind of Floor					
History					
Clear Span under Coping					
Distance "C to C" of Piers					
Size under Coping of Pier No					
" " " " " " No.					
Length of Stem Wall-N. or E. End					
" " " " S. or W. "					
Thickness " " N. or E. "					
" " " " S. or W. "					
Dist. B.R. to Top of Stem Wall N.or E.End					
" B.R. " " " " S. or W. "					
Pier No. ---- Founded on					
" " ---- Built of					
Pier No ---- Founded on					
" " ---- Built of					
History					
Alignment					
Super-elevation					
Grade					
Angle with Stream or Road					
High Water					
Paint Record					

BILL OF TIMBER FOR RENEWAL

PCS.	SIZE	LENGTH	REMARKS

NOTE:—Use Black Waterproof Ink.

A. B. & C. R. R.

OFFICE OF CHIEF ENGINEER.

Record of Trestle No._____. Name_____

_____Division. __N. or E. of_____Station

Class_____ *No. of Spans_____*

Survey Sta. No._____ *Total Length_____*

PHYSICAL DATA	INSPECTIONS			REPAIRS	
	DATE	INSPECT.	CONDITION & REMARKS	DATE	WORK DONE
Description					
History					
Area Drainage					
" Clear Waterway					
Dist. Base Rail to Cut off of Piles					
No of Piles to Bent					
Character of Soil					
High Water					

BILL OF TIMBER FOR RENEWAL.

PCS.	SIZE	LENGTH	REMARKS

PROFILE—
Show Grade and Surface, Spacing of Bents, Elevation of Rail, High & Low Water, Foundations, Penetration, Scales, Etc.

PLAN—
Show Alignment, Roads, Streams, Fences, Property Lines and Owners, Super-elevation, Direction of Stream, Mag. Bearing, Scale, Etc.

NOTE:—Use Black Waterproof Ink,

A. B. & C. R. R.

OFFICE OF CHIEF ENGINEER

*Record of Culvert No.*_____

_____*Division. N. or E. of M.P.*_____

Drawing Nos. _____

Corr. File Nos. _____

Survey Sta. No. _____ *Tel. Pole No.* _____

PHYSICAL DATA	INSPECTION			REPAIRS	
	DATE	INSPECT.	CONDITION	DATE	WORK DONE
Name of Stream					
Land on Right owned by					
" " Left " "					
Character of Land on Right					
" " " " Left					
Width of Right of Way on Right					
" " " " " " Left					
Dist. Center Track to Fence-Right					
" " " " " " -Left					
Direction of Flow.					
Drainage Area (Acres)					
Character of Area Drained					
Description of Culvert					
Section of Culvert					
Paving					
Foundation					
Protection at Lower End					
Protection at Upper End					
Length of Barrel					
Feet of Fall in Length					
Angle With Track					
Distance Base Rail to Flow Line					
History					
Construction					
High Water					
Litigation					

NOTE:—Use Black Waterproof Ink.

unimportant. The Committee believes that its position on this point is misunderstood.

There is a very large mileage of railroads, especially in the South and the Southwest, on which trestles predominate, and it would be very necessary on such roads to keep full and accurate records of these trestles.

It is believed that trestle records are important, but on account of the want of sufficient time for the proper investigation of the question of trestle records, the Committee refrained from making any recommendations regarding a form, or book, or method of record.

The Committee's position, outlined on page 55 of Bulletin 45, is that any complete bridge record book should be so flexible as to show all necessary information as to bridges, trestles, culverts, viaducts, crossings or any structure which necessarily comes under the care of a bridge department.

It is hoped that a greater number of members of the Association will give expression to their views on this question. The idea should be to design such an office record book, or form, or blank as will include bridges, trestles, culverts, viaducts and crossings. Whether this can be done conveniently, I am not prepared to state, because the Committee has received very little information or data bearing on this subject.

Mr. Walter G. Berg (Vice-Chairman of Committee—by letter) :—I agree with Mr. McDonald that separate blanks are desirable for bridges, trestles and culverts, and, further, that one blank should be used for each structure, and that suitable space should be reserved on each blank for the history and memoranda relating to litigation, high water, extensive repairs and renewals. I do not consider that the bridge record forms should give so much attention to the inspection records, and records of current repairs made, as shown in the blanks submitted by Mr. McDonald.

Mr. F. P. Gutelius (Canadian Pacific—by letter) :—Form M. W. 1000 indicates that the Master Carpenter is not expected to know the whereabouts or occupation of his gangs, except upon being advised by the foreman. A proper Master Carpenter has close practical control of all the works and gangs in his charge, and it is he who should arrange for the movements of the gangs, and he should instruct what job should next be undertaken. If the report is for record, it becomes a duplication of the timebook in this respect. The contention, therefore, is that this form is not only unnecessary, but that its use would not be good practice.

Foreman's Diary, Form M. W. 1002, is a material and structure report, which is duplicated by Form M. W. 1004. These two forms should be combined into a foreman's structure report, on which would be shown all the material used on each job. The back of the form should show a sketch of any changes made in the original structure. It should be forwarded to the Master Carpenter to fill in the price and amount, who, after making up his material report from this data and completing it, will forward it to the Division Engineer for his information and for accounting purposes.

It is recommended, therefore, that Forms M. W. 1002 and M. W. 1004 be replaced by a foreman's structure report.

In the matter of bridge inspection reports, the Committee recommends

Forms 1005, 1006 and 1007 in two sizes. It is recommended that a field bridge notebook and a report blank similarly ruled will answer all purposes, whether used by Bridge Inspector, Master Carpenter or Division Engineer, or whether made daily, monthly or annually.

It is suggested, therefore, that the two forms M. W. 1007 or a modification thereof only be adopted.

Mr. R. H. Reid (Lake Shore & M. S.—by letter):—I have studied over thoroughly the report of Committee No. 12, and have the following suggestions to make, looking at it from our point of view:

Form M. W. No. 1000:—Daily Report of Foreman of Bridges. I would make this Daily Report of Bridge Foremen, and at the end of the first blank space, after stating the amount of work done during the day, would add the following, "making a total of ..... on this job," the idea being to keep the office at all times advised of the present condition of each job; also, at the bottom of the card, I would say Foreman's time must be included in the above, instead of saying it must *not* be included, as I think it would give a better basis for comparison of the amount of money spent and work turned out each day by each gang. With these changes, I think this form is very good, and very desirable for keeping the office fully advised of all work under way on the road, and would recommend its adoption on our line.

Form M. W. No. 1001:—This form is desirable for keeping a check on material shipped to, and disposed of by, each gang, but do not think it necessary to send it beyond the office of the Superintendent of Bridges, as under our organization he is the man responsible for the use and care of material.

Form M. W. No. 1002:—This form I do not consider essential, and think that M. W. No. 1004 would suit the purpose fully as well, and perhaps better, and would be less expensive. I would recommend this as a form of report of Material used on each job.

Form M. W. No. 1003:—Bridge Department Tool Report, is approved, but I would make the horizontal ruling four or five lines to the inch, instead of three lines as shown, as my experience has shown that this ruling can very easily be used for reports of Foremen, and, in fact, the horizontal ruling for all blank forms could be made of the same size.

Form M. W. No. 1005:—This form I do not consider essential nor desirable under our organization, as we have neither the organization to make this form of a report on the road, nor to properly take care of it in the office. In its place I would use Form M. W. No. 1006, and have the reports come in covering the divisions, instead of coming in monthly or daily, as the working orders are made out for divisions, and in this way the reports would receive better attention. I do not consider a report of this form made out by the Division Engineer essential nor desirable, as all of the work of this kind is taken care of in the Bridge Department, not going beyond the Superintendent of Bridges. Horizontal ruling here should be not larger than four or five lines to the inch. On the middle of page No. 39, Bulletin No. 34, reference is made to several forms used on various roads with vertical or side head-

ings showing the various items to be investigated at each bridge. I do not consider these forms desirable, as unless a form had a very large number of headings it would not be applicable to all classes of structures, and if it did have so many headings a large number of them would be left blank on many of the structures. I think the better way would be as suggested in the paragraph just below this; that is, to issue instructions, rules, etc.

Form M. W. No. 1007:—General Bridge Inspection Report. The general form of this is approved, but I would reduce both the horizontal and vertical ruling in size, making the horizontal ruling not larger than five or six lines to the inch, and the vertical ruling enough to get on a 4-in. page what is shown here on a 5½-in., and I would have the record page independent of the remarks for inspection, and bound in loose leaf form, so that the inspection pages can be taken out from time to time as they become filled up without having to renew the record page, unless it is intended to print the record page, and keep it revised for printing, or else a sufficient clerical force is maintained to write up the record page for each inspection.

Exhibit "A":—I do not consider essential, as this applies only to wooden trestles, and does not cover culverts, truss bridges or other structures.

Exhibit "B":—I do not consider desirable nor suitable for the purpose, as room enough is not left for making sufficient notes of the condition of the parts. It might be well enough to print the list of side headings suggested here in the front of the inspection book, and leave the pages blank for the inspector to make such notes as might be applicable to the various structures, simply using this list in a general way to call his attention to the various parts to be examined.

Exhibit "C":—Is better than either of the two preceding, but I do not think that this allows sufficient room to make proper inspection notes of some of the parts. The printed directions on the back of this sheet I think are very good, and are suitable for any inspection blanks, and would be very desirable to print in the front of any inspection book. I think this is the best list of suggestions for inspection that I have seen.

Exhibit "D":—I do not consider it essential nor desirable for us, as we have not the organization to keep it up.

Exhibits "E and F":—Both show good forms of bridge and trestle records, but it would be desirable to have one form embrace both kinds of structures, if possible, and if this cannot be done, both forms should be on the same size of paper, so they can be bound together in a book to make a complete record of the division or road. The Pocketbook Record Book referred to at the bottom of page No. 46 I think is desirable, being a convenient form of record and inspection book to take out on each structure for the purpose of making notes while on the spot and while the evidence is before the inspector. I think we would get more accurate and satisfactory results from the general inspection in this way than we will with a record, which cannot be taken out on the structure during the inspection.

Mr. Edwin F. Wendt (Pittsburg & Lake Erie):—The Committee has undertaken to do one thing. On page 6 you will find a succinct statement of the purpose of the report, which I will read:

"The general purpose of the present report is to consider the various forms used in connection with records, reports and accounts of the regular bridge department of a railroad; to suggest to the Association for consideration and approval those special forms, solely for a bridge department, which are considered essential, together with such forms—complete in every respect as to size, title, ruling, etc.—as are recommended for adoption, and to collect, analyze and present to the Association certain forms as typical examples of certain classes of forms in use on some of the larger systems of railroads in America, which are not considered essential under all conditions, and hence are not recommended by the Committee for adoption."

Having in mind this definite purpose, the Committee submits to the Association three definitions, these definitions covering the three terms, records, reports and accounts. Following this, the Committee presents to the Association for consideration and adoption five conclusions, with the recommendation that the blank forms included in conclusion No. 1 be adopted by the Association. Following up the purpose of the report, let it be said that it is necessary for the Committee to determine what reports should be made, when and to whom they should be made. It was therefore necessary to outline the organization of a working bridge department. This is submitted with due apology to the Committee on Organization, hoping that the organization outlined is so elastic as to meet the ideas of all. After the Association has considered these definitions and these conclusions, we would also like an expression of opinion from the members regarding a statement contained in the report of 1901. That is as follows: "In 1901 no conclusions were formulated, but on page 322 of the Proceedings of the second annual convention it was recommended that duplicate copies of record books and maps, particularly right-of-way maps, should be kept in quite widely separated localities, so that the trouble and expense of reproducing the same would be greatly reduced in case of fire or accident."

In view of the great Baltimore fire, the convention may wish to consider that conclusion, which was never adopted by the Committee or the Association, but was in the report in the form of a recommendation.

Vice-President Kelley:—The report of the Committee is now open for discussion. I ask the convention in what manner they desire to take up the various points. Shall we take up the conclusions and go over them separately?

Mr. Hunter McDonald (Nashville, Chattanooga & St. Louis):—I move that we proceed under clause (b) of Rule 5, reading, discussing and acting on each clause.

Mr. Wendt:—I will say that through an oversight of the Committee the three definitions shown were not included among the conclusions. In reality, there should have been an additional conclusion containing these three definitions of records, reports and accounts. The Committee hopes that the convention will consider these recommended for adoption.

Vice-President Kelley:—The Secretary will read the conclusions in their order.

The Secretary:—"Your Committee submits to the Association the following conclusions, and requests that action be taken on the same at the annual meeting in March, 1904: (1) The following standard forms:

Report of Foreman of Bridges	M. W. 1000
Monthly bridge material report	M. W. 1001
Foreman's diary, Bridge Department	M. W. 1002
Bridge Department tool report	M. W. 1003
Structure report	M. W. 1004
Current bridge inspection report	M. W. 1005
Summary current bridge inspection report	M. W. 1006
General bridge inspection report	M. W. 1007

Mr. McDonald:—I think if we allow that conclusion to be adopted that we are going pretty swiftly. That means a great deal to us. I have heretofore, in a written discussion, called attention to some defects in these reports, and possibly there are some others that I have noticed since that time that I want to call attention to. One of them is the fact that the form of tool report is entirely too small. If you undertake to list the tools that belong to a bridge gang on the size of report that has been submitted, you will find it absolutely impossible. I have recently undertaken it, and find that it requires nearly four pages of the size of this report to include the tools that are ordinarily used by carpenter and masonry gangs.

With regard to the monthly bridge material report, I presume the Committee has the idea that each foreman has charge of a certain district and that he is responsible for the material assigned to him. Unless that is the case, the material report should not be made out by the foreman, because he has no jurisdiction over any material on the division unless he has charge of the district on which that material is placed. I ask the Committee whether, in submitting this form M. W. 1001 for adoption, that is their idea—that the foreman has charge of material within a certain district.

Vice-President Kelley:—This report is a very valuable one, and one to which we have not given any attention in the past years, and the point brought forth by President McDonald is worthy of considerable thought, as to the size of the report. I know that in our own practice the size of the sheet given would not answer our purposes.

Mr. Wendt:—I think it would be well to make a short explanation with regard to that. In Bulletin No. 45, page 23, will be found the first form, No. 1000, a report made by a foreman of bridges. As originally included in Bulletin No. 34, this was a daily report. The Committee, however, does not so recommend, and you will notice that the form now presented is a report of a foreman of bridges, not to be made daily or weekly, but to be made periodically, according to whatever system may be established on a particular railroad. For instance, it was the idea of the Committee that on a large system of, we may say, 1,000 or 2,000 miles, there would be a number of extra gangs engaged in different classes of work, such as pile driving or the erection of steel bridges, or

other work, and that such a blank would be used by the heads of these gangs to report to the head office, which might be 500 miles or 1,000 miles distant, and that the report should be made only when the gang moved from one location to another. The second blank, No. 1001, is a report to be made monthly by the foreman of bridges with respect to the material found on his subdivision. The blank or form was drawn up with the idea that the foreman of bridges had charge of all materials within his district, and that district might be shorter or longer. The size of the blank is in accordance with the decision of the Committee that, as far as possible, blanks should be 8 in. by 13 in.; if, however, a particular road wishes to amplify the blank or in a measure change it, there would be no objection, because it is impossible to design one form that will suit the conditions or requirements on every railroad, North, South, East and West. The Committee does, however, specify in this form the information which is needed by the office in order to have an accurate check on materials used, received, on hand or shipped away. You will next find blank No. 1002, known as a foreman's diary. I think the members will more readily understand this blank as illustrated in the leaflet which accompanies the report. It is the idea of the Committee that this form should be made up by the foreman of bridges and used as a diary, in order that he would not rely on memory for reporting material. The written matter accompanying that form is very clear with regard to its purpose. Taking up the question of a tool report form, known as 1003, found on page 34, the criticism of President McDonald is met in this way: The form may be doubled or increased in size, as you may see fit. This is drawn according to the standard of the Committee, size 8 in. by 13 in. It was our idea that a road requiring a blank twice this size would double the sheet, that is, continue the 13-in. size and double the width, making it 16 in. In other words, make the size of the blank whatever you may think best for your own requirements, keeping it as small as possible, and, where possible, make it 8 by 13, which is a convenient size. We found that many railroads required their carpenters to furnish their own tools largely; therefore a very small blank would be required. As President McDonald states, on some of the roads there is a larger number of tools, where a larger blank would be needed. The size is not insisted upon, but it is thought the report would be sent in probably four times a year, and the information needed by the office would be as indicated on this form. These four forms have been drawn up in accordance with a general scheme, and no criticism of this report will be intelligent unless it is fully understood that the blanks are designed with reference to a general scheme, one form being probably dependent on the other, and the information given in the entire number of forms being such as will keep the office fully informed with regard to the operations of the bridge department.

Mr. W. M. Camp (Railway and Engineering Review):—I would like to ask the chairman of the Committee if the form of these reports is not the important feature; and where is the advantage in recommending a uniform size for different roads?

Mr. Wendt:—As far as possible, blanks should be as small as possible, that is to say, no more paper should be used than is necessary for the purpose. Economy is thus secured in several ways. Eight by 13 in. was adopted because that is a commercial size. When the report is attached to a letterhead, it will fold just right and will fit the usual size envelope.

Vice-President Kelley:—If there is no further discussion, the conclusion will be considered adopted as read. The second conclusion reads: "In bridge inspections there should be a clear distinction made between current inspection and general inspection. The purpose of the current inspection is to keep the structure in safe condition, to promptly discover any defects, and to report same promptly, so that repairs can be made before the safety of the structure is affected.

"It is important that a simple record should be made while at the bridge and the superior officer kept advised of all such inspections promptly, whether made by a bridge mechanic, gang foreman, division bridge inspector, Master Carpenter, or others.

"The purpose of the general inspection, frequently called the annual inspection, although in many cases conducted semi-annually, or even quarterly, is not only to check the maintenance work of the division organization, but to make a more careful investigation of important bridges and structures on the entire road, and, further, to ascertain and settle what extensive repair work or renewal work should be done in the following working season."

Is there any discussion on the conclusion? If not, it will stand approved as read. The Secretary will read the third conclusion.

The Secretary:—"The general forms of the railroad should be used in all departments, including the Bridge Department, as far as applicable; for example, one form for reporting time should be used in all departments, the blank being designed accordingly."

Vice-President Kelley:—Is there any objection to the conclusion? There is none, and it stands approved as read.

The Secretary:—"Bridge records, etc., marked Exhibits 'D,' 'E,' 'F,' 'H,' 'K.' These records when properly kept up to date in an accurate manner, will prove of highest value to railroads, and are essential for any system of complete and proper bridge records. However, the Committee believes that such forms are not necessary specially for a Bridge Department, but are necessary generally for the compilation of records for several departments, and hence these forms are not recommended as standard special Bridge Department forms.

"Furthermore, greater study should be given to the subject of bridge office records before any conclusion is finally formulated by the Committee for submission to the Association."

Vice-President Kelley:—Any discussion on conclusion No. 4? There is none, and it stands approved as read.

The Secretary:—"Numerous minor forms are used on all railroads for reporting information necessary to keep bridge records up to date, but, in the opinion of the Committee, such forms should be regulated

by each individual road according to its peculiar requirements, and hence no standard forms for this purpose have been prepared and none are recommended to the Association for adoption."

Vice-President Kelley:—Is there any discussion on conclusion No. 5? If there is no objection, it will stand approved as read. The chairman of the Committee has intimated a desire to include, as an additional conclusion No. 6, certain definitions appearing on page 5. The Secretary will read the definitions.

The Secretary:—"Three definitions are submitted for adoption: (a) Records.—Records consist of information or data in graphical, tabular or statement form, relating to the physical characteristics, condition, cost and such other information as may seem desirable for record.

"(b) Reports.—Reports consist of the medium through which information is transmitted from a subordinate official to a higher official, and from which records and accounts are prepared or compiled in the filing office.

"(c) Accounts.—Accounts cover all statements required to enable payments to be made for labor performed and material furnished, and all statements necessary in order to establish the detail, total and comparative cost of work and various classes of expenses."

Vice-President Kelley:—The Committee desires that these definitions be considered as conclusion No. 6.

Mr. F. E. Schall (Lehigh Valley):—I move that the definitions be considered as conclusion No. 6 and adopted.

(The motion was carried.)

Mr. Wendt:—The Committee desires to call attention to Article 3, on page 5, which reads as follows: "Ledger Accounts.—There being no agreement among maintenance engineers regarding the value of ledger accounts, the Committee feels justified in taking the position that the record of cost of annual maintenance for each individual structure is desirable, and will prove valuable information if accurately and continuously kept for a long term of years, but does not think such information is absolutely essential, and, therefore, no special blank or form for the purpose is recommended for adoption."

Mr. McDonald:—I am in hopes that the sentiment of the members will be brought out on this question. The Committee's future action is largely dependent upon it, that is, whether their form of record shall be prepared in such a way as to include accounts of expense, or whether simply records of the physical condition of the bridges. I have already expressed my own views on that subject in writing, that it is unprofitable and unnecessary to keep ledger accounts. It possibly might be advantageous to keep ledger accounts of the cost of the more important of the large bridges on the road, but as to individual ledger accounts against every small bridge and trestle, I think it a useless expense, and at all events it belongs in the auditing department and not in that of the engineering and maintenance of way.

Vice-President Kelley:—Mr. McDonald has brought forth a very interesting feature, a feature which has been taken up by the Auditors' Association, but the Committee would like further discussion.

Mr. J. A. Atwood (Pittsburg & Lake Erie):—It is my opinion that the expense necessary to properly carry out the question of ledger accounts is an unwarrantable expense. What an engineer wants is information as to units of value, and not necessarily information as to the cost of one particular structure or piece of work. If it is necessary to find the cost of one particular piece of work, it can be dug out of the accounts so that bills can be made, but to keep long ledger accounts against every individual structure along the line of a road is entailing an expense that I think is unnecessary.

Mr. Wendt:—The Committee would state its position in this way: We would be glad to have the convention discuss the question or give their views as to what ledger accounts should be kept, and to what extent money should be expended for the keeping of ledger accounts. In this connection blank form No. 1004 might be discussed, because it is what is known as a structure report, which would include the cost of a given piece of work, from which would be deduced the unit cost.

Mr. C. S. Churchill (Norfolk & Western):—It seems that in the line of economy on a railroad, the important thing to have in mind is the obtaining of an estimate of the money that must be expended on these structures for an entire year, with the aim that, by making a careful estimate of the requirements, we will get the work done at the lowest possible cost. When this plan is carried out, an incentive is given to the men to do the work reasonably, and the result at the end of the year is that the estimates are probably lived up to, barring, of course, certain emergencies; and the grand result is that cheap maintenance is secured. We have for many years carried out that system. The annual bridge inspection is made use of in preparing a detailed estimate of the cost of the work that must be done on each bridge for the entire coming year, barring emergencies, and this estimate is turned over to each master carpenter, who works to that. On wooden structures, for example, by keeping track of the cost per 1,000 feet, framing his lumber, and putting it in the structure. This cost is recorded and a statement of it is sent monthly to the master carpenter of all the divisions, so that each division knows what the other people are doing and each man knows how his work compares in cost with the work of the others. In that way we have saved a good deal of money. I think when we accomplish that, there is no need of an after record of the cost. The result we are seeking is cheap maintenance and proper maintenance, and if the cost of such maintenance within a year has been kept within the estimates, we have accomplished that result. I think that a ledger account should not be necessary, but almost an equal amount of work should be done beforehand, and by doing it at beginning of a year, we will secure what is wanted, namely, cheap, maintenance, and, at the same time, first-class maintenance.

Vice-President Kelley:—Any further discussion? I would add, that when we recommend with reference to ledger accounts, we are invading the province of the auditor, but the information the maintenance engineer wants can be had in the maintenance engineer's office, which is the system he adopts. The auditor keeps no separate account of the

different structures, but the cost of the work done on each structure is kept in the office of the Engineer of Maintenance of Way.

Mr. Walter G. Berg (Lehigh Valley):—The term "ledger account," adopted by the Committee, does not refer to the auditor's ledger account, or any very heavy system of double entry bookkeeping. It simply uses the general term to distinguish whether an attempt shall be made to get the total cost of a certain structure or piece of work, and in that sense it is what Mr. Churchill outlines, collecting expenses against each piece of work, obtaining the unit expense per thousand, per yard, or whatever it might be—that is what the Committee means. It means that at any time, immediately after the work is done or in subsequent years, there is a record of some kind which will show how much money a certain piece of work costs, and to be used not only for record of the facts, but for comparative purposes, both as to the work done before and work done later on. The question whether such accounts or records should be kept, so that the cost can be brought out at any time, is one that, I believe, is discussed by engineers when they are among themselves, but apparently not in conventions. It is desirable information to have, provided it is carried out consistently, conscientiously and continually through a long series of years, and my experience has been not only on roads I have been connected with, but I have seen it on others. A system is often started by the enthusiasm of some individual engineer in control at the time, kept up a year or two and then dropped when he leaves, as his successors in the position do not seem to realize there is any importance in keeping up the figures.

Vice-President Kelley:—If there is no further discussion, the Secretary will read under the heading "Summary of Conclusions," on page 4, opposite 1901.

The Secretary:—"No conclusions were formulated, but on page 322 of the Proceedings of the second annual convention it was recommended that duplicate copies of record books and maps, particularly right-of-way maps, should be kept in quite widely separated localities, so that the trouble and expense of reproducing the same will be greatly reduced in case of fire or accident."

Mr. Wendt:—It was found that while no formal conclusions were made in 1901, there was in the Proceedings this recommendation, which, however, did not come before the convention in a formal way. In view of the Baltimore fire, it was thought probable the convention might wish to say something along this line, and we suggest that this conclusion be included as No. 7 under this year's report. We would also like to know the sense of the convention regarding the idea expressed. The conclusion would, therefore, stand: "It is recommended that duplicate copies of record books and maps, particularly right-of-way maps, should be kept in quite widely separated localities, so that the trouble and expense of reproducing the same will be greatly reduced in the case of fire or accident."

Mr. John Dean (Civil Engineer):—I move that the recommendation as read be adopted.

(The motion was carried.)

Vice-President Kelley:—It is now in order to consider what action the convention will take upon the report as a whole.

Mr. McDonald:—I believe the Committee was instructed to confer with another committee, and we would like to have a statement from them as to their progress.

Mr. Berg:—The Committee was instructed to take up the questions of the distinction between repairs and improvements, the classification of maintenance of way expenses, and to confer with the Association of American Railway Accounting Officers. The Committee, in its report, states that a subcommittee was formed, and the chairman of the whole Committee and the chairman of the subcommittee took up the matter with the Association of American Railway Accounting Officers. The matter was considered and referred by that association to their executive committee, who subsequently appointed a subcommittee of accounting officers to confer with the subcommittee of this Association. These subcommittees have conferred in a preliminary way, and the matter as it now stands is that no action can be taken at the present time. The accounting officers expect to submit the matter to their convention, to be held in May at St. Louis, and we will then hear further in the matter.

Mr. McDonald:—The Committee, on page 13, states: "Your Committee presents a progress report and requests that the subject be submitted to it for further report." I move the subject be referred to the Committee for further report and that they continue their efforts with the Association of Accounting Officers to procure some consideration of that question.

(The motion was carried.)

REPORT OF COMMITTEE NO. IX.—ON SIGNS, FENCES, CROSSINGS AND CATTLE-GUARDS.

To the Members of the American Railway Engineering and Maintenance of Way Association:

Your Committee on Signs, Fences, Crossings and Cattle-Guards submits herewith to the Association its fifth annual report. This report was prepared for submission at the annual convention in March, 1903, but was not reached for discussion and was consequently not printed in the Proceedings. It was presented, however, as Bulletin No. 34, and the report herewith submitted is the same, with the exception of some recommendations that are made for standard construction in woven and barbed wire fences.

In pursuance with instructions from the Board of Direction, discussion of the report was requested from a large number of engineers. But three answers were received, however, these being published in the Appendix.

But one meeting has been held by the Committee since the convention in March, 1903. This was held at the rooms of the Association in Chicago on December 10th. The following members were present: A. S. Baldwin, chairman; E. G. Ericson, vice-chairman, and T. L. Hanley. The Committee was in session the entire day. In addition to revising previous report, a sub-committee, consisting of Mr. E. G. Ericson and Mr. C. H. Ewing, was appointed to investigate and report on the present methods of galvanizing wire for fencing purposes; reference to which is made in the body of the report.

The following is a summary of conclusions in previous reports:

SUMMARY OF CONCLUSIONS IN PREVIOUS REPORTS.

1900: The Committee submitted only a verbal report, outlining the manner in which it proposed to carry on its work.

1901: The report for 1901 related to the safety of highway grade crossings, but contained no conclusions or recommendations. (Pp. 326-330, Vol. 2, 1901.) The Committee submitted as an appendix to its report a synopsis of the laws of the different states and territories regarding highway grade crossings. (Pp. 383-481, Vol. 2, 1901.)

1902: The report for 1902 dealt with the subject of surface crossings—consideration as to protection of same, planking of approaches, etc., and crossing gates—pneumatic, hydraulic, electrical or physical operation. The report was referred back to the Committee for further consideration, and was not printed in Proceedings.

1903: The report for 1903 treated of the subjects of fences and cattle-guards, and contained the following recommendations:

(1) The use of woven wire in preference to barbed wire for railroad fences; (2) The use of a heavier pattern of woven wire than has generally been adopted; (3) The use of a heavy smooth wire, a twisted barbless cable, or a plank at top of barbed wire fence; (4) The use of the surface in preference to the pit cattle-guard.

FENCES.

HISTORICAL.

It is probable that the original form of fence was a rough wooden stockade, or a stone wall, for protection against human foes and wild animals. This was doubtless followed by the heap of stones or arrangement of branches and twigs, and later by saplings, laid up "worm" fashion, for protection of growing crops. From this came, with advance in the art of making tools, split rails, the stake and rider fence, and the paneled rail fence in which the posts were slotted to receive the ends of the rails. With the introduction of saw mills came in natural sequence the ordinary post and board and the picket fence. The necessity for a light and inexpensive, but easily constructed and effectual fence, as to large stock, with which to enclose great areas of land on the Western prairies, brought out the barbed wire, a material for fencing for some time peculiar to this country. This was rapidly adopted by both farmers and railroads, but is now being superseded, in a large measure, by some of the various forms of woven wire, in which the barbs are omitted.

It is possible that the hedge fence is almost as old an institution as any of the forms mentioned, and it is being used to-day quite extensively for railroad as well as farm fencing. No fence presents a more pleasing appearance than one composed of a neatly trimmed and well-kept hedge. The serious objection to such fences is that too frequently they are destroyed by fires on the right-of-way.

ANALYTICAL.

The stone fence is particularly suitable for railroad purposes. Where properly built it is durable, effective as to all kinds of live stock, and presents an absolute barrier to the passage of fire from the right-of-way to adjoining fields. This method of construction is limited, of course, to the comparatively small area of the country in which suitable stone can be found. An excellent combination of stone and wire can be made in many places by the use of common field stones, built in a low wall of broad base, surrounding the fence posts and surmounted by woven wire. Farmers will often join in the construction of such fences at a low price in order to clear their fields of the stones.

For enclosing station grounds some form of ornamental fence should generally be used. The Committee will not make any definite recommendation on this subject, but feels that the hedge fence might in many instances be adopted to good advantage.

Almost all of the before-mentioned forms of fence have been used for the purpose of defining the right-of-way and keeping stock from the track, but so universal for railroad purposes has become the use of the woven and barbed wire fences that this report is practically restricted to the consideration of fences of that description.

Various forms of plank, rail or hedge fences are being used to protect the roadbed against drifting snow, but this report does not include the subject of snow fences.

The following glossary of names of the various parts of fence, with their definitions, is recommended for adoption:

DEFINITIONS.

FENCE POST.—An upright piece of timber, metal or other material used as a support for the attachment of the horizontal members of the fence.

*END POST.—A post at the end of a line of fence.

*GATE POST.—An end post to which a gate is hung or latched.

INTERMEDIATE POST.—Any post used between end posts.

CLEAT.—A piece of wood or metal fastened transversely to the sides of a post below the ground line to give it greater stability.

*BRACE.—A piece of timber or metal placed diagonally or horizontally between the end post and the next intermediate post for the purpose of maintaining the end post in an upright position.

*TIE WIRE.—A wire in tension between the end post and the next intermediate post used to assist the brace.

*BOTTOM WIRE.—The horizontal wire at the bottom of a fence.

*INTERMEDIATE WIRE.—Any horizontal wire coming between the top and bottom wire.

STAY.—A form of timber, metal or other material, whether vertical or inclined, serving the purpose of keeping the horizontal wires the proper distance apart and stiffening the fence.

STAY WIRE.—A stay formed of wire.

FENCE STAPLE.—A metal device, in the shape of the letter "U" with ends sharpened, for fastening the horizontal members of the fence to the post.

*PANEL.—A section of fence between two adjoining posts.

BRACE PANEL.—A panel in which a brace, or tie, or both are introduced.

GATE FRAME.—The sustaining parts of a gate, fitted and framed together, to which the other horizontal and vertical members are attached.

GATE BRACE.—A piece of wood or metal serving the purpose of stiffening the frame of a gate.

GATE HINGE.—A device for attaching a gate to a post and upon which the gate swings.

*GATE LATCH.—A device for fastening the swinging end of a gate to a gate post.

*GATE.—A movable barrier consisting of a frame or structure of wood, metal or other material swinging on hinges or pivots for closing a passage or opening in a fence.

*See amendments, page 390.

FENCE.—A line of posts and rails or wires, or of boards and pickets; a wall, hedge, ditch, trench, bank or anything that serves to guard against unrestricted ingress and egress.

SPECIFICATIONS.

*FENCE POSTS can be made of wood, steel, concrete, burnt clay, or combinations of concrete and burnt clay with steel.

Fence posts made of steel have been in use for a number of years. The experience so far has been that they can not, even with frequent painting, be made durable enough to be economical.

Concrete or burnt clay posts have thus far not been in use to any great extent. From what your Committee has seen of these posts it feels that they have promise of success.

Specifications are given for timber posts only.

The names of timbers indigenous to this country, which are best suited for use as fence posts, are given in the table following, with a recommendation as to minimum diameter, if round, or girth, if split, of small end, and as to proper size of staples to be used with each kind. The approximate value for fence purposes is about as in the order named:

	Round, Min. Diameter at Small End, Inches.	Split, Min. Girth at Small End, Inches.	Suitable Length for Staples, Inches.
Catalpa	4	14	1¼
Bois D'Arc (Osage Orange)	3½	13	1
Red Cedar	5	18	1¾
Black Cypress	4	16	1¾
Redwood	4½	18	1½
Locust	4	16	1
Post Oak	4½	16	1
Chestnut	5	18	1½
Chestnut Oak	4½	16	1¼
White Oak	4½	16	1
Yellow Pine	5	18	1¼
Spruce	5	18	1½

The length of post recommended is, for general purposes, from seven and one-half to eight feet, depending upon character of soil and depth to which frost penetrates.

All posts should be set plumb and true to line and should be thoroughly tamped.

END POSTS.—As the life and stability of a fence depend in a large measure upon the end posts, they should be of good size and well anchored and braced. A size of 8x8 inches, or 8 inches in diameter if round, and 9 feet long, is recommended for ordinary purposes. They should be carefully set at least four feet in the ground and thoroughly tamped. Where end posts of proper size can not be obtained, cleats and braces should be used as given under "anchoring."

*See amendments, page 390.

GATE POSTS should be of same dimensions and set in the same manner as end posts, except as to depth in the ground, which should be 3 feet 8 inches, so as to allow a slight projection above the general level of the fence.

INTERMEDIATE POSTS should be of the dimensions given in the table and should be set from two and a half to three feet in the ground, the depth depending upon the soil and climate. They should be spaced, for woven wire fence, 33 1-3 feet apart where the surface of the ground will permit. If a plank is used at top, 1x6 in. is recommended, to be nailed to the face of the post, in which case the top smooth wire and next lower barbed wire should be omitted and posts spaced eight feet apart.

ANCHORING.—In rolling country posts coming in depressions of the ground should be anchored. This can be accomplished by fastening cleats to the sides of the post near the bottom, these cleats to be from 2x4 inches, 16 inches long, to 2x6 inches, 24 inches long, depending upon conditions, or by running stay or brace wires from the top of the lowermost post to within a few inches of the ground line of the posts next adjoining on either side.

BRACING.—All end and corner posts should be well braced, anchored and tamped. The fence should be under strong tension at all times, and unless end posts are of proper size and well braced this can not be maintained. Brace panels should be introduced at least every half mile.

WIRE.—Your Committee recommends the use of woven wire in preference to barbed wire for fences, and suggests the following minimum number, gauge and spacing of wires:

Number of horizontal wires	9
Top wire	Gauge No. 7
Bottom wire	Gauge No. 7
Intermediate wires	Gauge No. 9
Stay wires	Gauge No. 11

The spacing of horizontal wires to be, commencing at the bottom, 4, 4½, 5, 5½, 6, 7, 8 and 9 in.; the bottom wire to be 3 in. above the ground; the spacing of the stay wires to be 12 in. apart.

This gives a 49-in. weave, the top wire coming 52 in. above the ground. The weight of this fence will be

Per rod	12½ lbs.
Per 100 feet	76¼ lbs.
Per mile	4,030 lbs.

Heavier top and bottom wires are recommended than are generally being used. The life of the fence largely depends upon these two wires, and both are subject to greater strains than the other wires, the bottom wire in addition having excessive corrosive influences to contend with.

While your Committee recommends as a standard the woven wire fence, the following recommendations are made for the construction of the barbed wire fence where used.

For a hog-proof barbed wire fence the description of wires and spacing should be as follows:

Commencing at the bottom, the first four wires to be "thick set," with four-point barbs, 3 in. apart, the spacing of these wires to be 3, 4

and 5 in. respectively. The next four wires to be "regular" or "cattle," with two-point barbs, 5 in. apart, the spacing to be 6, 7 and 8 in., numbering upwards. The top wire to be No. 7 gauge, plain wire, 8 in. above the next lower wire. The bottom wire to be 3 in. from the ground. If a plank is used at top, one 1 by 6 in. is recommended, to be nailed to the face of the post, in which case the top smooth wire and the next lower barbed wire should be omitted.

A bottom plank is not recommended on account of its being subject to rapid decay and liable to be burned by fires on the right of way.

If difficulty is found in maintaining a hog-proof fence with the spacing of wires recommended, the introduction of vertical stays is suggested; these stays to be of No. 7 wire, spaced not more than 3 feet apart.

For a cattle-proof barbed wire fence, five wires, spaced from ground to bottom wire 6 in. and remaining wires spaced 10, 12, 12 and 12 in. is recommended, the wires to be "regular" or "cattle," with single barbs 5 in. apart.

It is to be understood that these recommendations are made from a construction standpoint only, and should be considered in connection with the statutes of each State in which the fencing is done. An abstract of these statutes is being prepared for publication in the Proceedings.

The wires should be placed on the side of the post away from the track, except on curves, where they should be so placed that the pull of the wires is against the post.

All wires and staples should be thoroughly galvanized. Attention is called to the fact that there is a general and apparently well-founded complaint in regard to the rapid deterioration of the so-called galvanized wire. Your Committee is investigating this matter, but is not prepared as yet to make any recommendations.

Gates.—Your Committee recommends a minimum width of farm crossing gate of 12 feet. The farm gate generally in use to-day in railroad right-of-way fences is a wooden gate made of 1x6-in., 1x4-in. or sometimes 1x3-in. boards, fastened together with carriage bolts or wire nails clinched. These gates have so far been found to answer all purposes, to be durable, and inexpensive to maintain.

In the light of present experience the ordinary wooden farm gate, when well constructed, is, in the opinion of the Committee, as effective and economical as any other kind.

There are a number of metal gates on the market, some of which will probably fill all the requirements at a reasonable price. None of these, however, have been in use a sufficient length of time to enable your Committee to form a definite opinion as to their merits as compared with the ordinary wooden farm gate.

Gates should be so hung as to open towards the track where width of right-of-way will permit, and to swing shut by gravity.

In the Appendix are given:

1. A table of general fencing information, so arranged in units of rods, 100 feet and miles, that quantities for all kinds of barbed wire, feet board measure for planks, the number of posts, staples, etc., can be

arrived at for any style of fence with but little calculation. With this table can be used also any of the forms of patented fences illustrated in Bulletin No. 34, by applying the information given on the cuts.

2. Cuts of smooth and barbed wires, nails, etc., with information useful in connection with fencing.

3. Cuts of standard fences and specifications therefor of a number of railroads, the designs being selected so as to give as great a diversity of practice as possible.

In Bulletin No. 34, March, 1903, are shown cuts of various forms of manufacturers' fences, all on the same scale, with details as to weight of wires, stiffeners, etc., designed to enable a fair comparison to be made between them. Also an abstract from the laws of each State in the Union and Canada which relate to fencing of railroads.

CATTLE-GUARDS.

HISTORICAL.

In the early history of railroading in this country no effort appears to have been made for continuous fencing of the right-of-way. The division fences of farms were carried up to the track, and it being impracticable to continue the fence across the track, some form of barrier was necessitated, to prevent stock from wandering from one field to another. This barrier appears to have been called from the outset a "cattle-guard." The first form of cattle-guard was probably an open pit spanned by stringers resting upon mud sills. This was gradually elaborated into the pit-guard with timber or masonry walls, stringers carrying the rails across the opening. The vibration caused by trains shook the rubble walls ordinarily constructed to pieces, and timbers finally came into general use. These timber guards were generally constructed of two 12-in. beams, one over the other, on which were placed stringers about 12x14 in. in size and 8 ft. long. Where these guards were situated in embankments or where drainage could be secured, they were effectual in preventing the passage of stock, except in winter, when filled with snow or ice or, where located in cuttings, with mud and water. The softening of roadbed in such undrained locations, and consequent heaving from frost in cold weather, was destructive to the surface of track, and required continual attention on the part of the track men. In very soft material it was sometimes necessary to make a pile foundation, but this produced too great rigidity and was likewise objectionable. In quite early practice thin longitudinal strips of timber were sometimes laid edge up across the tops of the end pieces or sills and parallel with the stringers to afford footing for pedestrians and to prevent cattle from falling into the pits. It was from this type that the surface cattle-guard of to-day was probably developed.

The certainty of piling up cars if a wheel broke or left the rails while approaching a pit-guard necessitated the use of ties in addition to the stringers, the corners of the ties being turned up or chamfered so as to afford insecure foothold for the track-walking stock.

ANALYTICAL.

To all forms of pit-guards there are, however, serious objections, as enumerated herewith:

(1) Cattle are liable to fall into the guard and are then unable to extricate themselves.

(2) On account of inability to properly drain in many localities water accumulates in the pit, and the surface of the track is affected both by the heaving from frost and by settling.

(3) The guards occasionally catch fire and burn out.

(4) When the wheels of a car which have become derailed come in contact with a pit-guard the ties are bunched together and wrecks caused, whereas otherwise the train might have been stopped before any serious damage was done.

(5) They are expensive both as to first cost and maintenance.

On account of these objections your Committee recommends that the use of pit guards be discontinued.

These defects in and serious objections to the pit-guard have led to its abolishment on a great number of railroads and to the substitution therefor of some form of surface guard. Some of these surface guards are made of wood, others of metal, others again of combinations of wood and metal, and of other materials. Some of them are very simple in their construction, consisting merely of triangular slats either nailed to the ties or fastened together in sections, each section being fastened to the ties; others are very formidable looking contrivances, of perforated iron with sharp triangular points turned up, saw-tooth arrangement, etc.

DEFINITIONS.

The following glossary of names of the various parts of surface cattle-guards, with their definitions, is recommended for adoption:

*Slat.—A strip of wood or metal, to be used singly or in groups, to make up sections of a cattle-guard.

*Section.—A group of slats or strips, or an arrangement of bent or perforated sheets of metal, which go to make up a cattle-guard. Ordinarily four, but sometimes three, sections are required to make one complete guard.

*Filler.—The piece of timber, metal or other material used between the slats composing a section to space and stiffen them.

*Cattle-Guard.—A barrier used at the intersection of a line of fence with a railroad track to prevent the passage of live stock along the track.

*Apron.—The flaring panel of fence set parallel with the track to make connection between the cattle-guard and the wing fence.

Wing Fence.—The line of fence making connection between the "apron" of the cattle-guard and the right-of-way or line fence.

*See amendments, page 390.

SPECIFICATIONS.

Your Committee recommends the use of a surface cattle-guard, and that it be designed as nearly as possible to meet the following requirements:

(1) It should be so constructed as to overcome the objectionable features of the pit-guard, particularly so far as endangering trains is concerned. Projecting surfaces which would be liable to be caught by dragging brake or other rigging should be avoided.

*(2) It should be of such construction as not to endanger employés who are compelled to pass over it in the discharge of their duties.

(3) It should be effective as to all kinds of live stock, and at the same time have no parts which would catch and hold stock that might endeavor to pass.

(4) It should be reasonable in first cost, durable and easily applied and removed, so as to allow repairs of track at minimum expense.

(5) It should not rattle during the passage of trains.

While no guard has been found that will meet all of these requirements, a great many railroad companies to-day are being put to serious inconvenience and great expense because of the fact that while supplying the best device in the form of a cattle-guard that can be obtained, they are unable as yet to supply a guard which is absolutely effectual in turning stock, and are continually being subjected to loss on account of suits for damages due to cattle passing over guards and getting into crops or being killed. It is the opinion of your Committee that it is not equitable that railroad companies should thus be held liable for failure to supply a perfectly efficacious guard when no such device has as yet been invented, and that their duty should be completed when they furnish and maintain in good condition some form of guard which is up to the best standard of the art.

It is suggested that in those states where the laws require the maintenance of cattle-guards at road crossings it would be desirable to have the railroad commission, or other proper authority if they have any jurisdiction over the question, pass upon the different surface guards in use and on the market, specifying which of them come within the requirements of the statutes. This has been done in the state of Michigan, and the letter of endorsement is given herewith. In case no authority is vested in any commission that will make its decision of value, the only recourse appears to be in an effort to obtain more favorable legislation, as your Committee is of the opinion that no guard is likely to be invented that will invariably turn stock. Observation shows that in many cases cattle do not stop to examine a guard before essaying to cross it, but plunge in regardless of consequences. It is a fact that, in doing so with pit-guards, they do not get over so frequently as with surface guards, but, falling between the ties, are then unable to extricate themselves.

*See amendments, page 390.

STATE OF MICHIGAN.

OFFICE OF THE COMMISSIONER OF RAILROADS.

To General Managers and Superintendents of Railroads in the State of Michigan:

Application having been made by —— —— for the official approval of the —— —— Surface Cattle-Guard, pursuant to the provisions of Section 15, Act No. 198, of the Session Laws of 1873, and acts amendatory thereof, as amended by Act No. 26, Session Laws of 1889. And the undersigned, Commissioner of Railroads in and for said State aforesaid, having made a careful examination of said cattle-guard, and become fully satisfied of its practical value, and that it meets the requirements of the laws of this state, in accordance with the true spirit and intent thereof,

Therefore, The said —— —— Surface Cattle-Guard is hereby approved, and authorized to be used upon all railroads in this state from and after the date hereof.

In witness whereof, I have hereunto set my hand, and caused the Seal of the Department to be affixed at the Capitol in the City of Lansing, this 9th day of August, A. D. 1894.

[SEAL.] *Commissioner of Railroads.*

In the Appendix are given cuts of standard cattle-guards and wing fences of a number of railroads.

In Bulletin No. 34, March, 1903, the Committee illustrated various forms of patented cattle-guards, all on the same scale, with dimensions of sections recommended by the manufacturers, thickness of metal used, weight of the different sections, and amount of projection above or below the base of the rail—this in order that a fair comparison can be made. Also, an abstract from the laws relating to cattle-guards in each state of the Union and Canada.

CONCLUSIONS.*

Your Committee submits the following recommendations for adoption by the Association:

UNDER "FENCES."

1. The use of woven wire in preference to barbed wire for railroad fences.
2. The use of a heavier pattern of woven wire than has generally been adopted.
3. The use of a heavy smooth wire, or a plank at top of barbed wire fence.

UNDER "CATTLE-GUARDS."

1. The use of the surface in preference to the pit cattle-guard.

Respectfully submitted,

A. S. BALDWIN, *Chairman;* Engineer of Construction, Illinois Central Railroad, Chicago, Ill.

*See amendments, page 390.

E. G. Ericson, *Vice-Chairman;* Principal Assistant Engineer, Pennsylvania Lines, Pittsburg, Pa.
H. Baker, Superintendent, Southern Railway, Charlotte, N. C.
C. F. Blue, Roadmaster, Mobile & Ohio Railroad, Cairo, Ill.
C. H. Ewing, Division Engineer, Philadelphia & Reading Railway, Reading, Pa.
T. L. Hanley, Assistant Engineer, Grand Trunk Railway, Marcellus, Mich.
A. G. Norton, Division Engineer, Baltimore & Ohio Railroad, Moundsville, W. Va.
W. D. Williams, Chief Engineer, Cincinnati Northern Railroad, Van Wert, O.

Committee.

AMENDMENTS.

Bottom Wire.—The lowest horizontal wire of a fence.

Brace.—A piece of timber or metal placed diagonally or horizontally between any post and the next post to it.

End Post.—A post at the end of a line or section of fence.

Gate.—A movable barrier consisting of a frame or structure of wood, metal or other material for closing a passage or opening in a fence.

Gate Latch.—A device for fastening the free end of a gate to a gate post.

Gate Post.—A post to which a gate is hung or latched.

Intermediate Wire.—Any horizontal wire located between top and bottom wires.

Panel.—A section of fence between adjoining posts.

Tie Wire.—A wire in tension between any two posts used to assist the brace.

Top Wire.—The highest horizontal wire of a fence.

Apron.—The flaring panel of fence set parallel with the track between the cattle-guard and the wing-fence.

Cattle-Guard.—A barrier used at the intersection of a wing-fence with a railroad track to prevent the passage of live stock along the track.

Section.—A group of slats or strips which go to make up a surface cattle-guard.

Filler.—A piece of timber, metal or other material used between the slats composing a section of a surface cattle-guard to space and stiffen them.

Slat.—Strips of wood or metal to be used singly or in groups to make up sections of a surface cattle-guard.

Conclusion No. 4 (Fences):—The Committee recommends the adoption of the definitions as given on pp. 5 and 6.

Conclusion No. 2 (Cattle-Guards):—The Committee recommends the adoption of the definitions and specifications as given on pp. 10 and 11.

(2) The cattle-guard should be of such construction as not to endanger employés who pass over it in the discharge of their duties.

TABLE SHOWING QUANTITY OF MATERIAL NEEDED FOR BARBED WIRE AND BOARD FENCES.

Spacing of Posts.	Posts.			Staples.												Nails.					
	Posts—No. Required.			Staples Required in Pounds—1 Strand of Wire.												Nails Required in Pounds—1 Board.					
				Per Rod.				Per 100 feet.				Per Mile.				Per Rod.		Per 100 ft.		Per Mile.	
	Per Rod	Per 100 ft.	Per Mile	1 in.	1¼ in.	1½ in.	1¾ in.	1 in.	1¼ in.	1½ in.	1¾ in.	1 in.	1¼ in.	1½ in.	1¾ in.	8d Com.	10d Com.	8d Com.	10d Com.	8d Com.	10d Com.
8	2.06	12.50	660.0	0.02	0.03	0.03	0.04	0.12	0.15	0.18	0.21	6 41	7.96	9.57	11.20	0.07	0.10	0.39	0.60	20 7	31.5
10	1.65	10.00	528.0	0.02	0.02	0 03	0.03	0.10	0.12	0.15	0.17	5.13	6.36	7.66	8.94	0.07	0.11	0.41	0 64	22.0	33.5
12	1.38	8.33	440.0	0.02	0.02	0.02	0.02	0.08	0.10	0.13	0.14	4.28	5.30	6.38	7.45	0.06	0.09	0.35	0.53	18.3	28.0
14	1.18	7.16	378.0	0.02	0.02	0.02	0.02	0.07	0.09	0.11	0.12	3.68	4.56	5.48	6.40	0.05	0.08	0.30	0.46	15.7	24.0
16	1.03	6.25	330.0	0.01	0.02	0.02	0 02	0.06	0.08	0.10	0.11	3.20	4.00	4.78	5.59	0.05	0.07	0 26	0.40	13.7	21.0
16½	1.00	6.06	320.0	0.01	0.02	0.02	0.02	0.06	0.08	0.09	0.10	3.11	3.86	4.64	5.42						
18	0.92	5.57	294.0	0.01	0.02	0.02	0.02	0.06	0.07	0.08	0.09	2.86	3.54	4.26	4.98						
20	0.83	5.00	264.0	0.01	0.01	0.02	0.02	0.05	0.06	0.07	0.09	2.56	3.18	3.83	4.47						
22	0.75	4.54	240.0	0.01	0.01	0.02	0.02	0.05	0.06	0.07	0.08	2.34	2.89	3.48	4.06						
24	0.69	4.17	220.0	0.01	0.01	0.01	0 01	0.04	0.05	0.06	0.07	2.14	2.66	3.19	3.73						
26	0.64	3.86	204.0	0.01	0.01	0.01	0.01	0.04	0.05	0.06	0.07	2.00	2.46	2.96	3.46						
28	0.59	3.58	189.0	0.01	0.01	0.01	0.01	0.04	0.04	0.06	0.06	1.84	2.28	2.74	3.20						
30	0.55	3.34	176.0	0.01	0.01	0.01	0.01	0.03	0.04	0.05	0.06	1.71	2.12	2.55	2.98						
33⅓	0.50	3.00	158.4	0.01	0.01	0 01	0.01	0 03	0.04	0.05	0.05	1.54	1.91	2.30	2.68						

NOTE—The quantity of nails required is figured on a basis of 2 nails to a board to each post.

Where posts are 8 feet apart it is figured to use a board 16 feet long.

BARBED WIRE FENCE

Style of Wire.	Gauge of Strand.	Spacing of Barbs.	Weight in Pounds.		
			Per Rod	Per100 ft.	Per Mile
Baker's Perfect, Regular or Cattle, 2 pt	12½	5 in.	0.88	5.31	280.0
" " Thickset or Hog, 2 pt	12½	3 "	0.97	5.87	310.0
Ellwood, Regular or Cattle, 4 pt	12½	5 "	0.94	5.68	300.0
" Thickset or Hog, 4 pt	12½	3 "	1.00	6.06	320.0
" Glidden, Regular or Cattle, 4 pt	12½	5 "	0.92	5.60	295.0
" " Thickset or Hog, 4 pt	12½	3 "	0.99	5.97	315.0
" Junior, Regular or Cattle, 2 pt	12½	5 "	0.88	5.31	280.0
" " Thickset or Hog, 2 pt	12½	3 "	0.94	5.68	300.0
Glidden, Regular or Cattle, 2 pt	12	5 "	1.00	6.06	320.0
" Thickset or Hog, 2 pt	12	3 "	1.08	6.54	345.0
Lyman, Regular or Cattle, 4 pt	12	5 "	1.14	6.92	365.0
" Thickset or Hog, 4 pt	12	3 "	1.25	7.58	400.0
Waukegan, Regular or Cattle, 2 pt	12½	5 "	0.87	5.26	277.5
" Thickset or Hog, 2 pt	12½	3 "	0.94	5.68	300.0

BOARD FENCE.

Size of Board.	Ft. B. M.		
	Per Rod	Per100 ft.	Per Mile
1"x 4"	5.50	33.33	1760.0
1 x 6	8.25	50.00	2640.0
1 x 8	11.00	66.67	3520.0
1 x10	13.75	83.34	4400.0
1 x12	16.50	100.00	5280.0

NOTE—The material given on the above tables is for one wire or one board high, in order that the material for fences of any number of wires or boards may be figured for different styles of wire and different sizes of boards.

Number of pounds of nails and staples is figured on an allowance of 5% to 10% for loss.

SMOOTH STEEL WIRES.

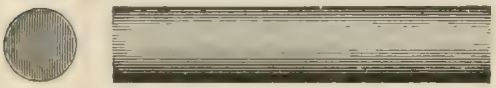
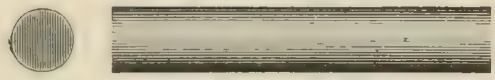
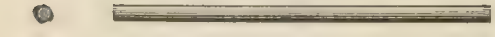
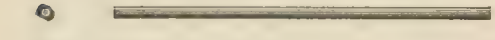
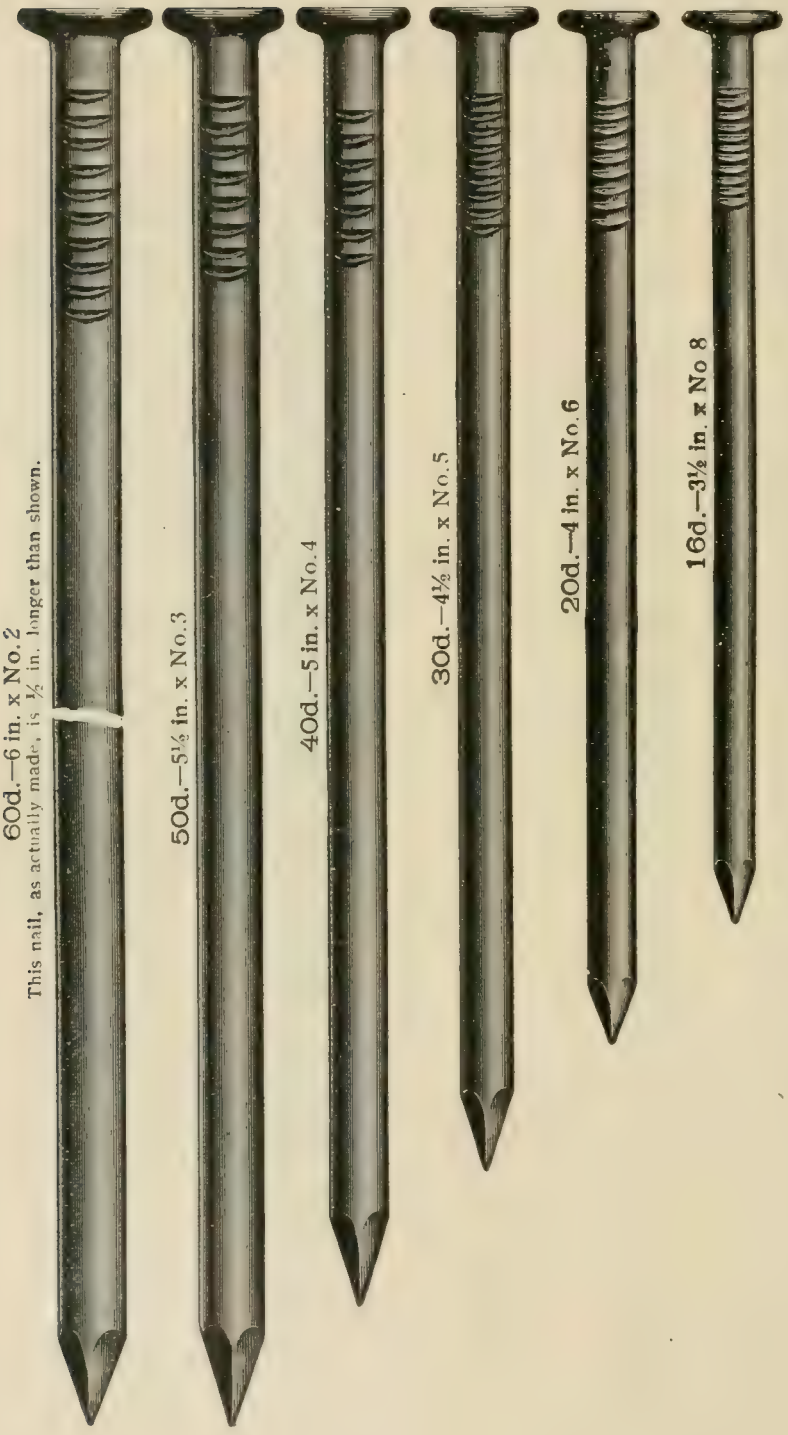
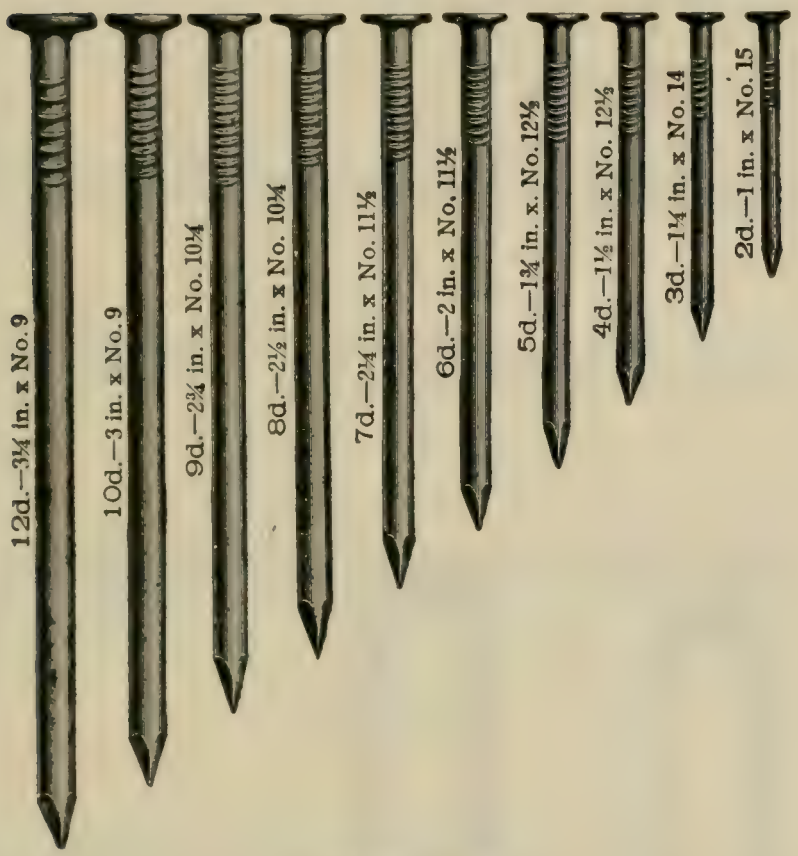
Cuts showing exact sizes of No. 1 to No. 20 gauge steel wire by American Steel & Wire Company gauge.	Gauge.	Lbs. to Mile.	Feet to 1 lb.
	1	1121	4.71
	2	968	5.45
	3	833	6.34
	4	707	7.47
	5	599	8.81
	6	514	10.28
	7	439	12.05
	8	367	14.37
	9	306	17.24
	10	255	20.70
	11	202	26.18
	12	154	34.25
	13	118	44.64
	14	89	59.17
	15	72	73.00
	16	55	95.24
	17	41	129.87
	18	31	172.11
	19	24	222.22
	20	17	312.50

TABLE OF COMPARATIVE SIZES WIRE GAUGE—In Decimels of an Inch.

No. of Wire Gauge.	A. S. & W. Co., or Washburn & Moen.	Birmingham, or Stubb's.	Brown & Sharpe.	English Legal Standard.	Old English, or London.
000000	.460	....	.....	.464	.....
00000	.430	....	.....	.432	.....
0000	.393	.454	.46000	.400	.4540
000	.362	.425	.40964	.372	.4250
00	.331	.380	.36480	.348	.3800
0	.307	.340	.32495	.324	.3400
1	.283	.300	.28930	.300	.3000
2	.263	.284	.25763	.276	.2840
3	.244	.259	.22942	.252	.2590
4	.225	.238	.20431	.232	.2380
5	.207	.220	.18194	.212	.2200
6	.192	.203	.16202	.192	.2030
7	.177	.180	.14428	.176	.1800
8	.162	.165	.12849	.160	.1650
9	.148	.148	.11443	.144	.1580
10	.135	.134	.10189	.128	.1340
11	.120	.120	.09074	.116	.1200
12	.105	.109	.08081	.104	.1090
13	.092	.095	.07196	.092	.0950
14	.080	.083	.06408	.080	.0830
15	.072	.072	.05707	.072	.0720
16	.063	.065	.05082	.064	.0650
17	.054	.058	.04526	.056	0580
18	.047	.049	.04030	.048	.0490
19	.041	.042	.03589	.040	.0400
20	.035	.035	.03196	.036	.0350
21	.032	.032	.02846	.032	.0315
22	.028	.028	.02535	.028	.0295
23	.025	.025	.02257	.024	.0270
24	.023	.022	.02010	.022	.0250
25	.020	.020	.01790	.020	.0230
26	.018	.018	.01594	.018	.0205
27	.017	.016	.01419	.0164	.01875
28	.016	.014	.01264	.0148	.01650
29	.015	.013	.01126	.0136	.01550
30	.014	.012	.01002	.0124	.01375
31	.0135	.010	.00893	.0116	.01225
32	.0130	.009	.00795	.0108	.01125
33	.0110	.008	.00708	.0100	.01025
34	.0100	.007	.00630	.0092	.00950
35	.0095	.005	.00561	.0084	.00900
36	.0090	.004	.00500	.0076	.00750
37	.0085	....	.00445	.0068	.00650
38	.0080	....	.00396	.0060	.00575
39	.0075	....	.00353	.0052	.00500
40	.0070	....	.00314	.0048	.00450


60d.—6 in. x No. 2
This nail, as actually made, is ½ in. longer than shown.
50d.—5½ in. x No. 3
40d.—5 in. x No. 4
30d.—4½ in. x No. 5
20d.—4 in. x No. 6
16d.—3½ in. x No 8



COMMON NAILS.

Size.	Length and Gauge.		Approximate No. to Lb.
2d	1 inch	No. 15	876
3d	1¼ "	" 14	568
4d	1½ "	" 12½	316
5d	1¾ "	" 12½	271
6d	2 "	" 11½	181
7d	2¼ "	" 11½	161
8d	2½ "	" 10¼	106
9d	2¾ "	" 10¼	96
10d	3 "	" 9	69
12d	3¼ "	" 9	63
16d	3½ "	" 8	49
20d	4 "	" 6	31
30d	4½ "	" 5	24
40d	5 "	" 4	18
50d	5½ "	" 3	14
60d	6 "	" 2	11

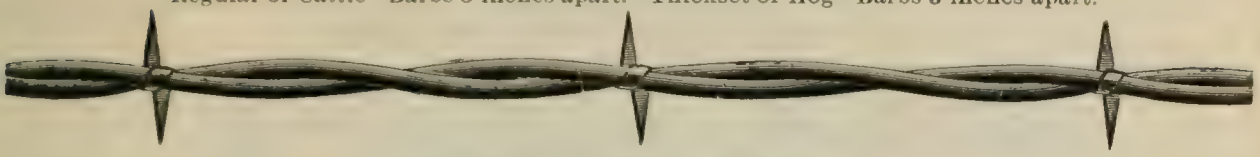
FENCE STAPLES.

1¼ in.

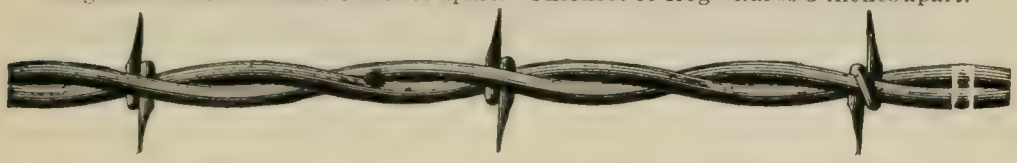
1½ in.

Length	No. to Lb.
⅞	120
1	108
1⅛	96
1¼	87
1½	72
1¾	65
2	58

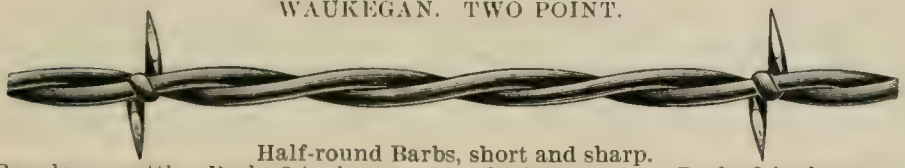
BAKER PERFECT. TWO POINT.
Flat Barbs, short and sharp.
Regular or Cattle—Barbs 5 inches apart. Thickset or Hog—Barbs 3 inches apart.



ELLWOOD JUNIOR. TWO POINT.
Half-round Barbs, short and sharp.
Regular or cattle—Barbs 5 inches apart. Thickset or Hog—Barbs 3 inches apart.

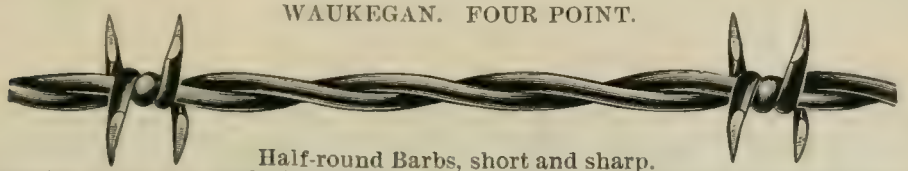


WAUKEGAN. TWO POINT.



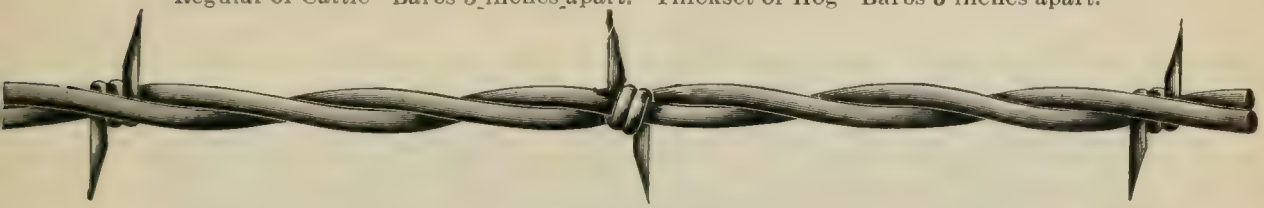
Half-round Barbs, short and sharp.
Regular or cattle—Barbs 5 inches apart. Thickset or Hog—Barbs 3 inches apart.

WAUKEGAN. FOUR POINT.

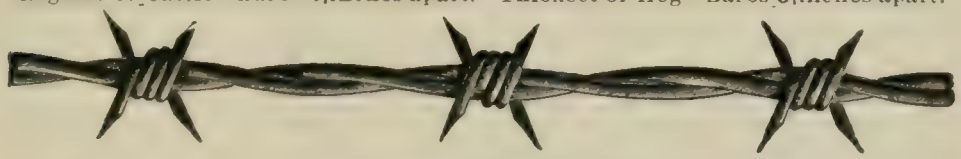


Half-round Barbs, short and sharp.
Regular or Cattle—Barbs 5 inches apart. Thickset or Hog—Barbs 3 inches apart.

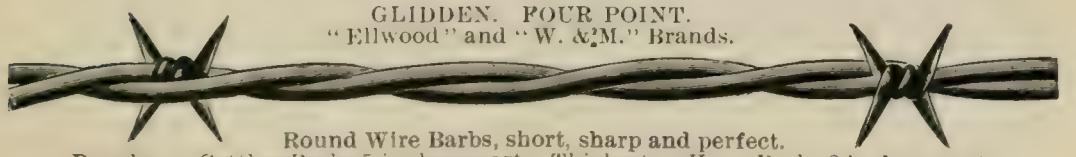
GLIDDEN. TWO POINT.
Round Barbs.
Regular or Cattle—Barbs 5 inches apart. Thickset or Hog—Barbs 3 inches apart.



LYMAN. FOUR POINT.
Round Barbs.
Regular or Cattle—Barbs 5 inches apart. Thickset or Hog—Barbs 3 inches apart.

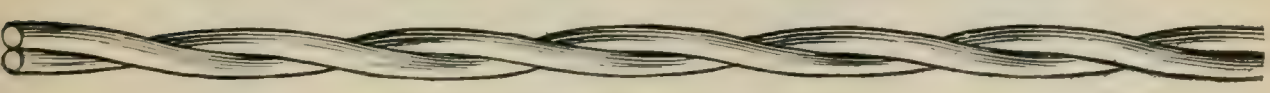


GLIDDEN. FOUR POINT.
"Ellwood" and "W. & M." Brands.



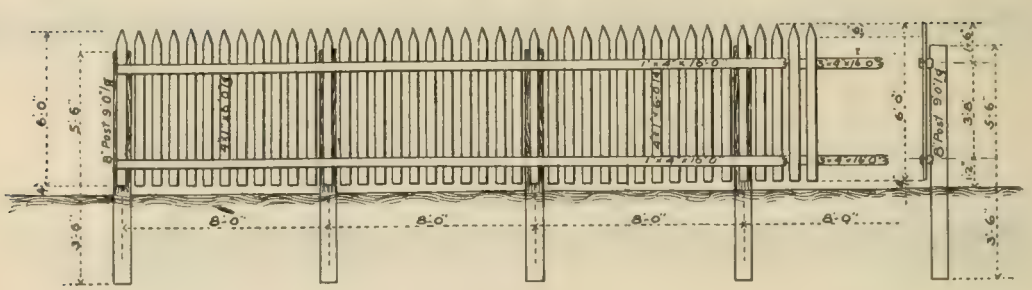
Round Wire Barbs, short, sharp and perfect.
Regular or Cattle—Barbs 5 inches apart. Thickset or Hog—Barbs 3 inches apart.

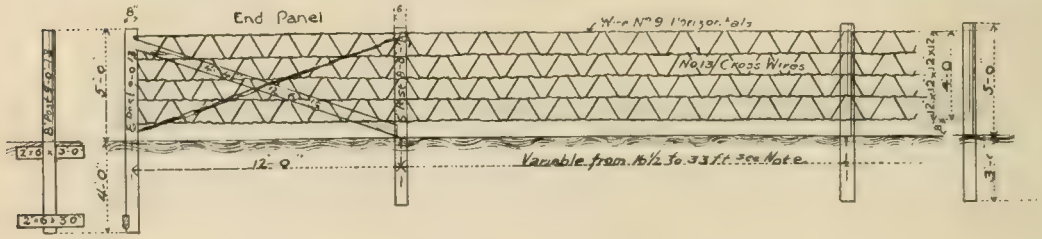
BARBLESS FENCING.
Two-Ply Twisted Galvanized Barbless Fencing. Sizes 11 to 14 inclusive.
3-Ply, 4-Ply, 5-Ply and 6-Ply Twisted Barbless Fencing. Sizes 7 to 14 inclsive.

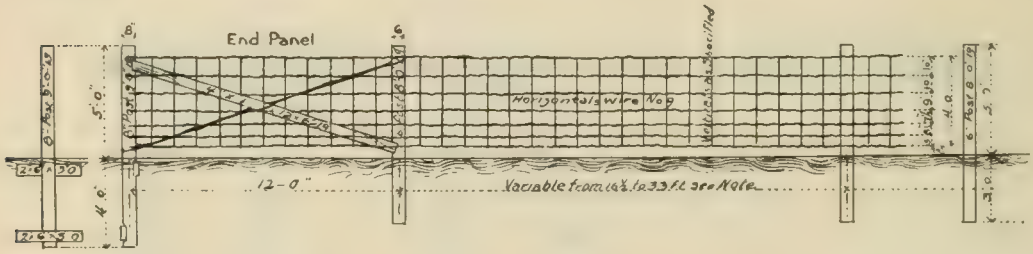


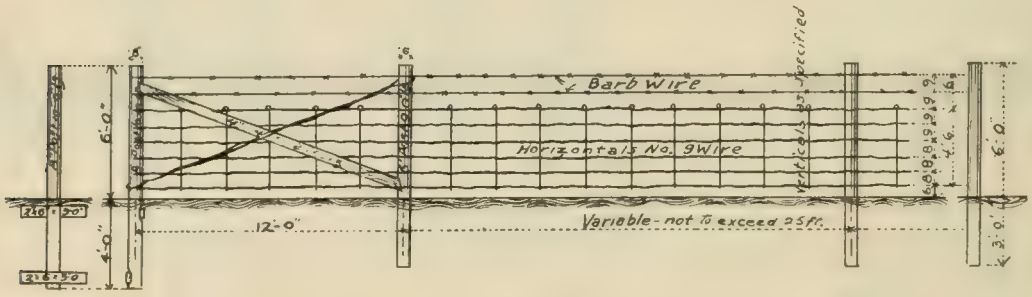
Twisted Ribbon Strand Barbless Fencing.

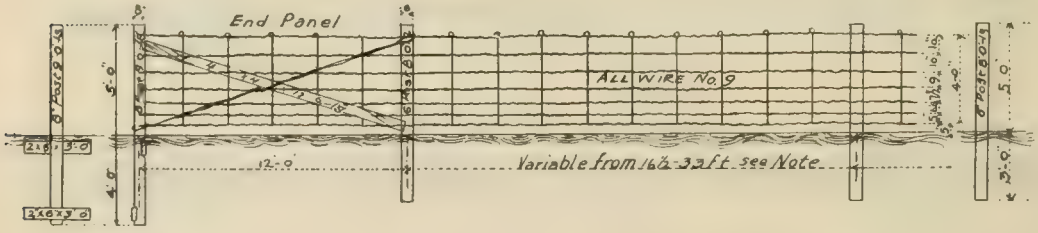
CANADIAN PACIFIC RAILWAY STANDARD FENCES.

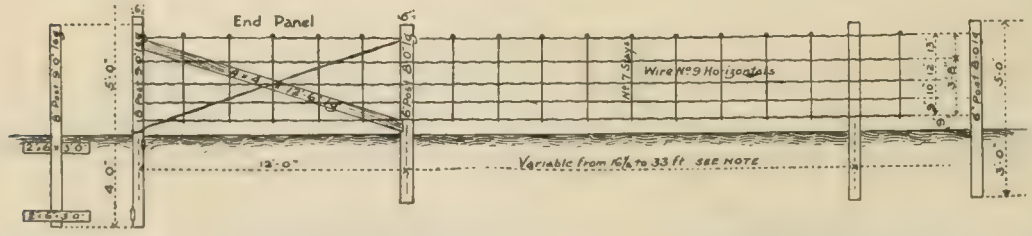




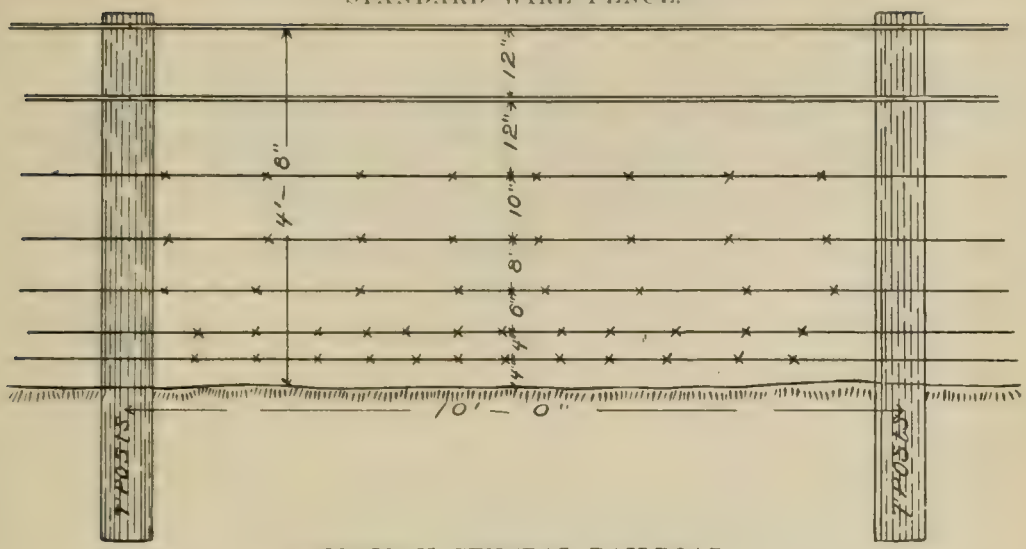




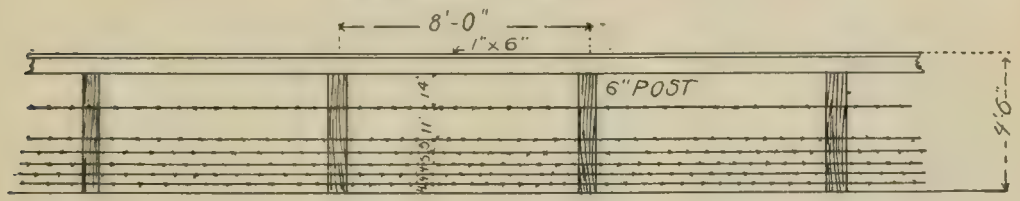




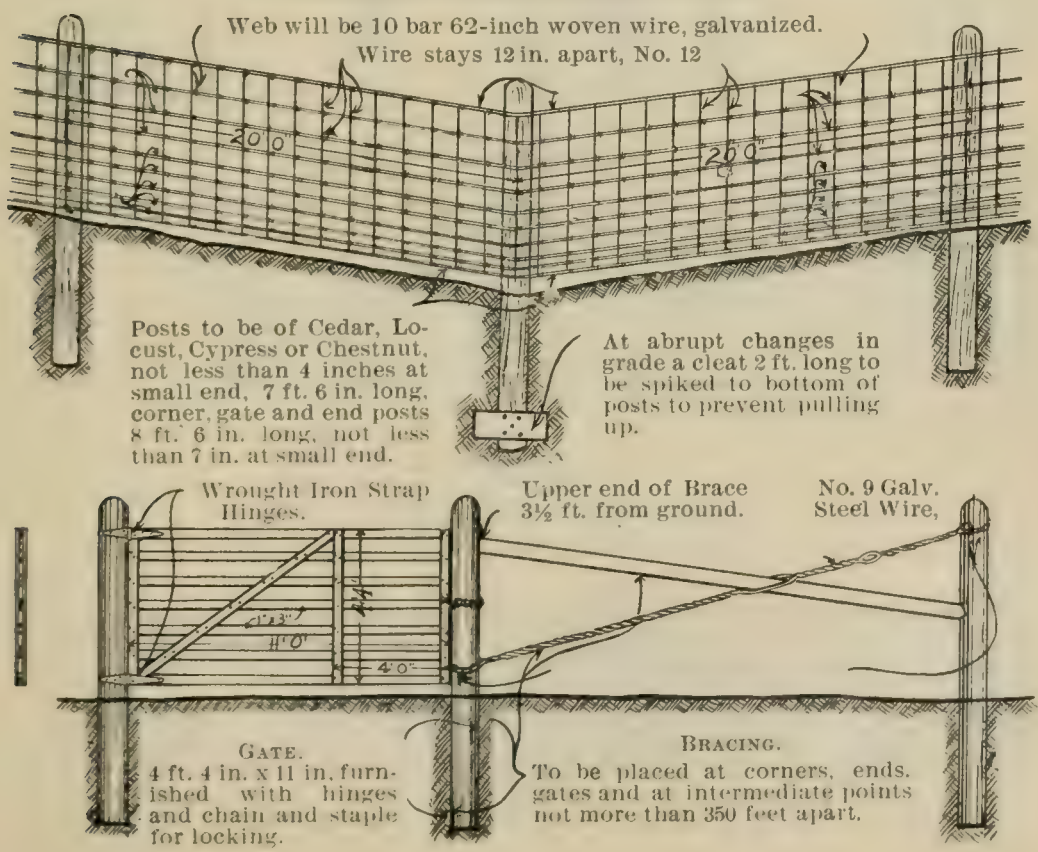
LOUISVILLE & NASHVILLE RAILROAD.
STANDARD WIRE FENCE.



MICHIGAN CENTRAL RAILROAD.
STANDARD WIRE FENCE.

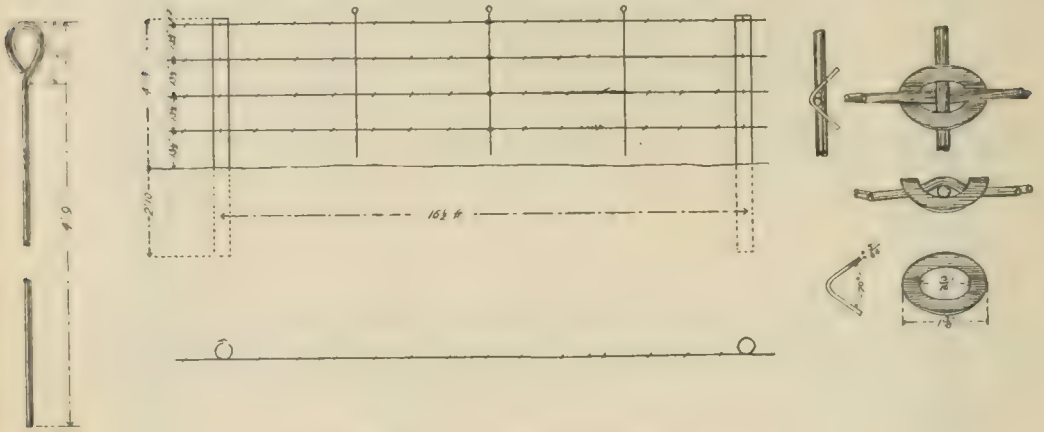


SOUTHERN RAILWAY.
STANDARD RIGHT-OF-WAY FENCE.



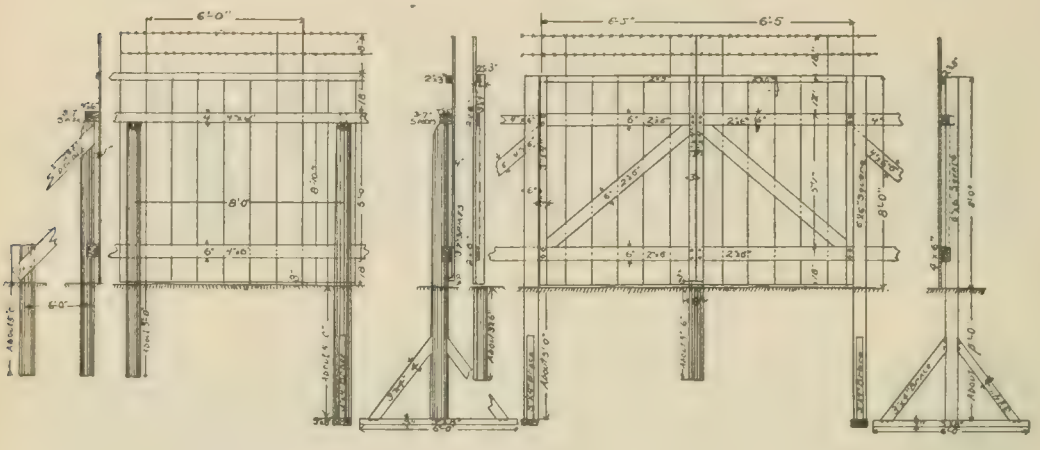
GREAT NORTHERN RAILWAY.

STANDARD RIGHT-OF-WAY FENCE.

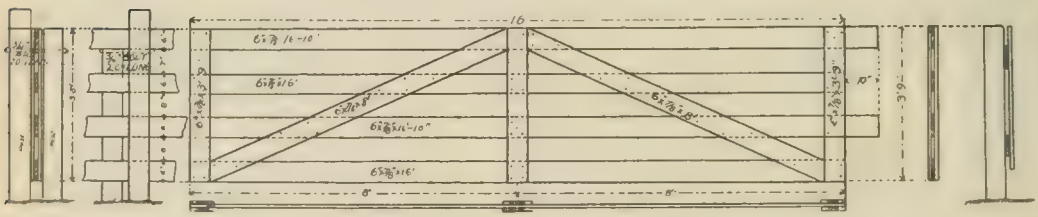


LEHIGH VALLEY RAILROAD.

STANDARD FENCES FOR SHOPS AND YARDS.

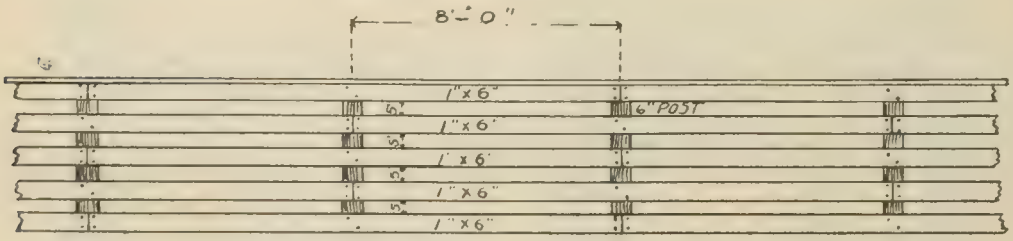


STANDARD FARM CROSSING GATE.



STATE OF MICHIGAN.

LEGAL RAILROAD FENCE.

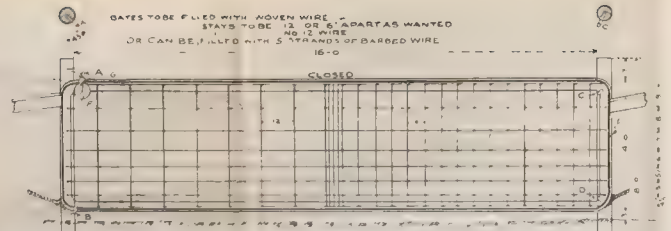


Am. Ry. Eng. & M. W. Assn.

Convention of 1904.

Committee on Signs, Fences, Crossings and Cattle-Guards.

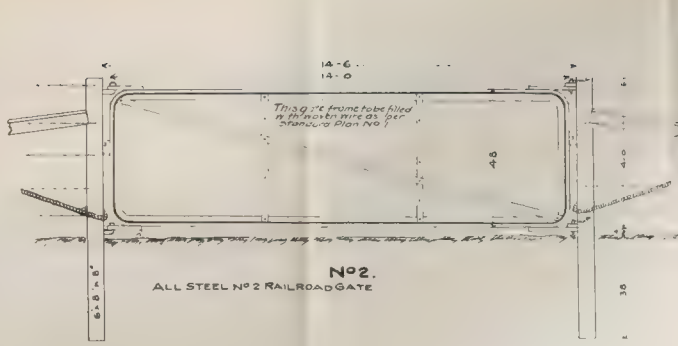
Standard Fences, Gates, etc., A. T. & S. F. Ry. System.



No 1.

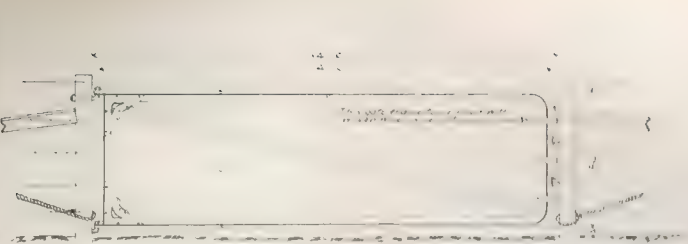
ALL STEEL YANKEE RAILROAD GATE -

Set posts 16 apart in the clear. Screw hanger hook A in post at an angle of 45° to the line of fence so that the gate may turn as shown in cut. Next place the hook B so the gate when closed is resting on it of the turn the hooks C and D can then be readily put in place.



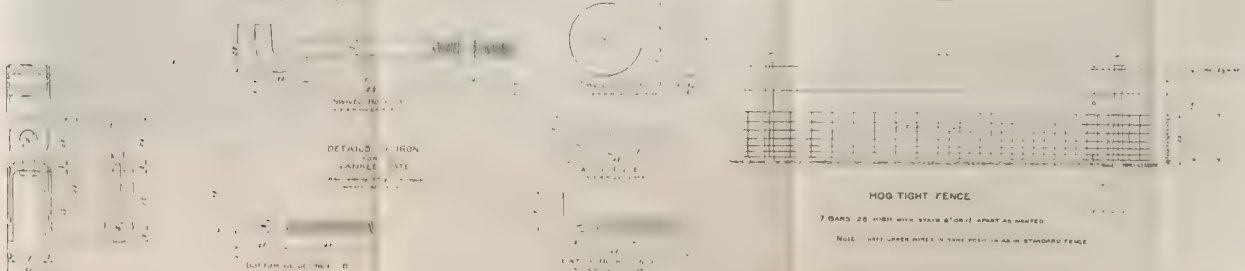
No 2.

ALL STEEL No 2 RAILROAD GATE



No 4.

ALL STEEL "T" FRAME HINGE FARMERS GATE



HOG TIGHT FENCE

7 BARS 28 HIGH WITH STAYS 6" OR 12 APART AS WANTED

NOTE - BEST OPEN WIRES IN SAME POSITION AS IN STANDARD FENCE

Specifications for Fencing A., T. & S. F. Ry. System.

for doing the work. The fence to be stretched in such a manner as to

GATES.—Gates will be put in where required by the Railway Com-

MATERIAL. Unless otherwise provided, the Railway Company will furnish all the material required for the fencing f. o. b. cars at the near-

distribute the material at his own cost and expense

Company

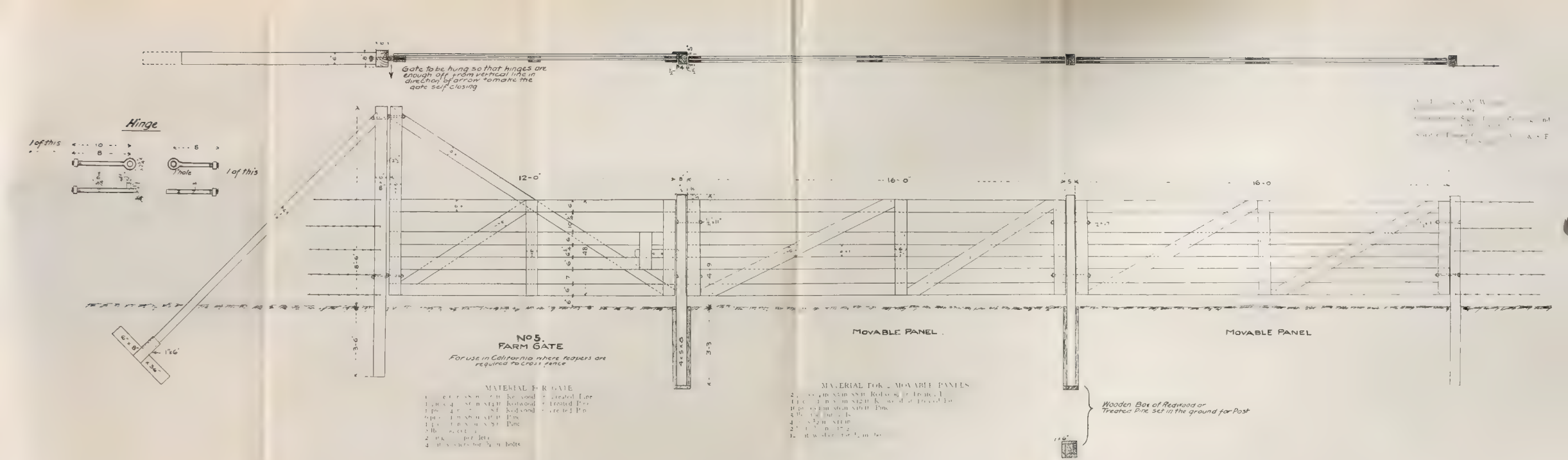
acceptance of the authorized agent of the Railway Company per cent contractor within 20 days thereafter. The remaining per cent shall be his own cost and expense, promptly remedy any such defects when called per cent retained shall be paid him by the Railway Company. In case days after receiving notice of same, then, and in that case the Railway

Am. Ry. Eng. & M. W. Assn.

Convention of 1904.

Committee on Signs, Fences, Crossings and Cattle-Guards.

Standard Fences, Gates, etc., A. T. & S. F. Ry. System.



No 5.
FARM GATE

For use in California where reapers are required to cross fence

MATERIAL FOR GATE

MATERIAL FOR 2 MOVABLE PANELS

STANDARD WING-FENCE, APRON AND CATTLE GUARD.

Pennsylvania Lines West of Pittsburgh.

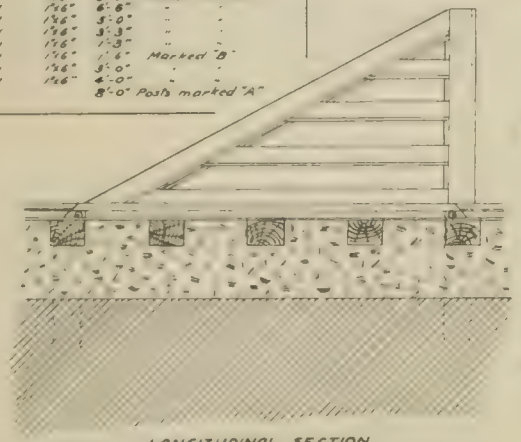
Scale; ½" and 1½" = 1 foot.

FENCE
BILL OF MATERIAL FOR ONE APRON.

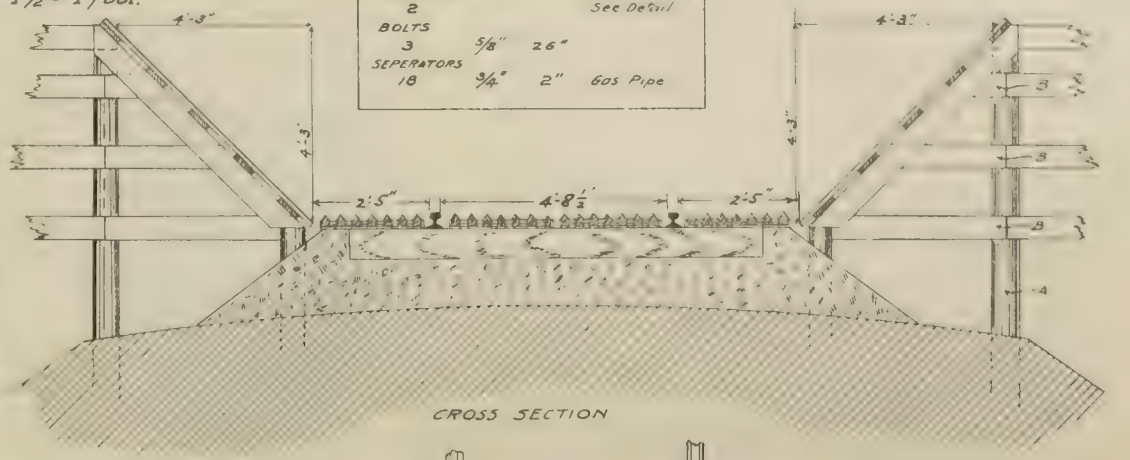
NO PCS.	SIZE.	LENGTH.	REMARKS.
2		4'-0"	Corner posts
			Ordinary fence posts
	PINE		cut in half
2	1"x6"	6'-3"	Framing boards
2	1"x6"	10'-6"	" "
1	1"x6"	8'-6"	Panel boards
1	1"x6"	6'-6"	" "
1	1"x6"	5'-0"	" "
1	1"x6"	3'-3"	" "
1	1"x6"	1'-3"	" "
1	1"x6"	1'-6"	Marked "B"
1	1"x6"	3'-0"	" "
1	1"x6"	4'-0"	" "
		8'-0"	Posts marked "A"

BILL OF MATERIAL FOR ONE SECTION OF GUARD.

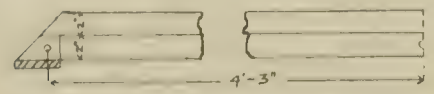
NO. PIECES	SIZE.	LENGTH.	REMARKS.
WHITE OAK			
7	½"x4"	9'-0"	
IRON PLATE			
2			See Detail
BOLTS			
3	⅝"	26"	
SEPERATORS			
18	¾"	2"	60S Pipe



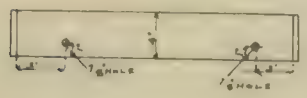
LONGITUDINAL SECTION.

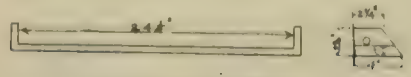


CROSS SECTION

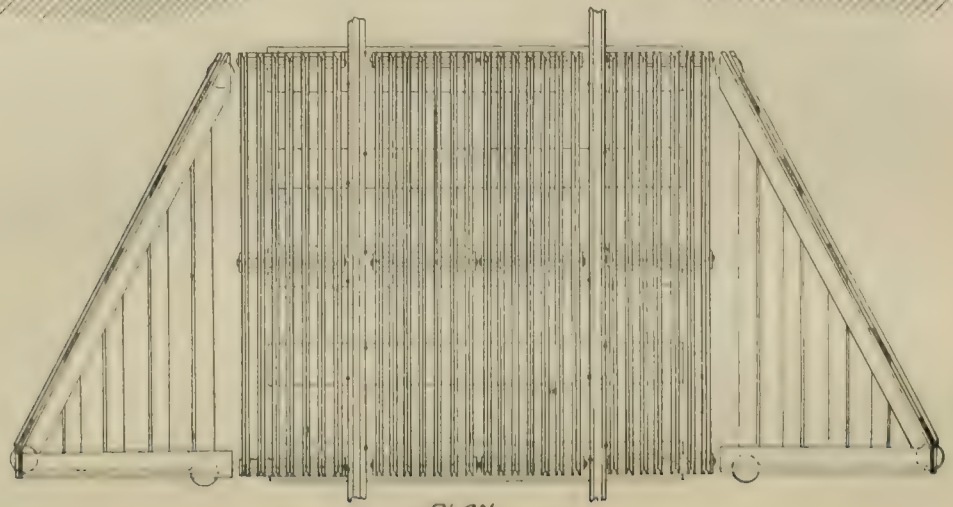


ELEVATION OF SLAT

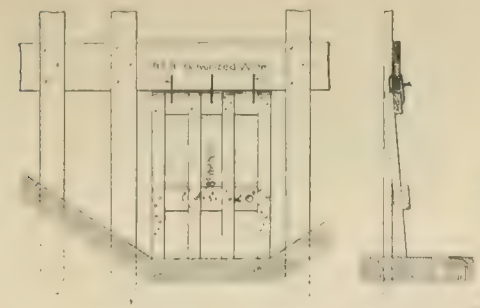




DETAIL OF PLATE



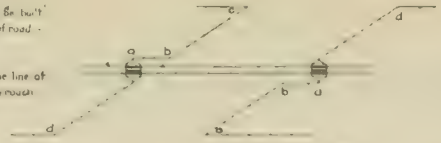
PLAN.



WATER GATE —— Scale 1½"-1'

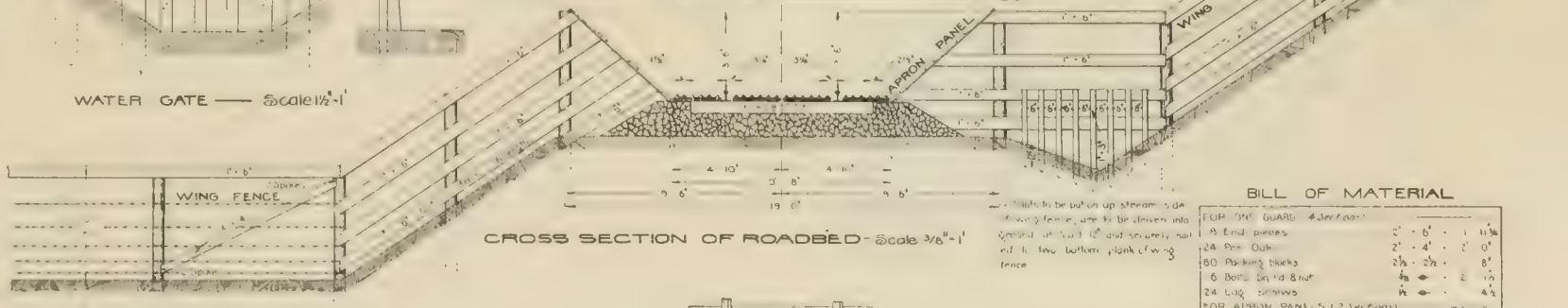
Where crossings are on a skew wing fences must be built parallel with the tracks to intersect with the line of road - as shown on sketch from a to b

In situations wing fence must be built exactly on the line of road as shown from c to d but must leave enough therefrom



SITUATION PLAN OF SKEW CROSSING— Scale 1"-50'

Or other sections of roadbed bottom plank (or planks) to be spaced so that there will be no openings greater than 4"



CROSS SECTION OF ROADBED- Scale ⅜"-1'

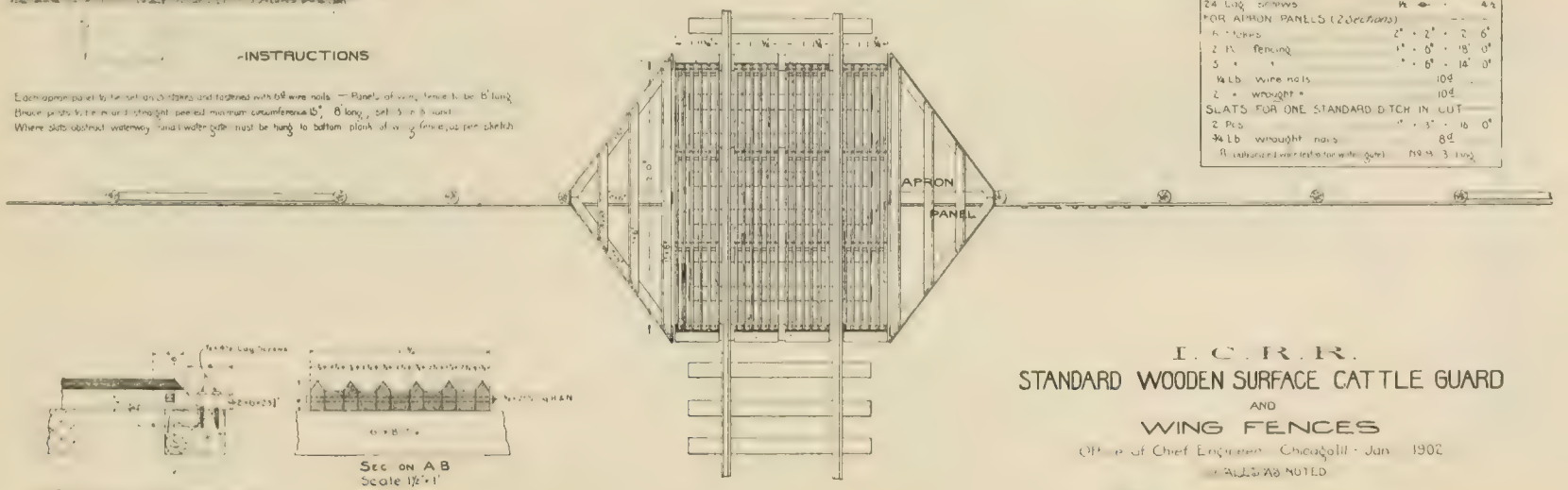
Stakes to be put up stream side of wing fence, are to be driven into ground at least 18" and securely nailed to two bottom planks of wing fence

BILL OF MATERIAL

FOR ONE GUARD (4 Sections)			
8 End pieces	2" · 6" ·	1	11⅜
24 Pcs Oak	2" · 4" ·	2'	0"
80 Packing blocks	2½ · 2½ ·		8"
6 Bolts 5/8" Rd & nut	⅝ ◆ ·	2	1/3
24 Lag screws	½ ◆ ·		4½
FOR APRON PANELS (2 Sections)			
4 Yokes	2" · 2" ·	2	6"
2 Pc fencing	1" · 6" ·	18'	0"
5 " "	" · 6" ·	14'	0"
¼ Lb wire nails		10¢	
¼ " wrought "		10¢	
SLATS FOR ONE STANDARD DITCH IN CUT			
2 Pcs	" · 3" ·	16	0"
¾ Lb wrought nails		8¢	
(Enlarged over-lap for wide gate)		1½ M	3 Lbs

-INSTRUCTIONS

Each apron panel to be set on 2 stakes and fastened with 10¢ wire nails — Panels of wing fence to be 8' long. Bruce posts to be of straight peeled minimum circumference 15", 8' long, set 3' in ground.
Where slats obstruct waterway "and" water gate must be hung to bottom plank of wing fence, as per sketch



DETAILS OF END - Scale 1½"-1'

Sec on A B
Scale 1½"-1'

PLAN —— Scale ⅜"= 1'

I. C. R. R.
STANDARD WOODEN SURFACE CATTLE GUARD
AND
WING FENCES

Office of Chief Engineer Chicago Ill - Jan 1902

As Altered & Noted

Approved: [illegible]
Chief Engineer

ABSTRACT OF LAWS RELATING TO FENCES AND CATTLE-GUARDS.

ALABAMA.

Fencing Railroads.—The only statute in this state with reference to fencing required of railroads, is prescribed by section 3495 of the Code of 1896. Authority is given the railroad commission, whenever they shall deem it necessary, to require railroads to fence their roads or any portion thereof. Should the railroad fail, after due notice, to fence the road or any portion thereof as required by the commission, the person or corporation operating such railroad is made liable in damages for the injury or killing of any stock, whether with or without negligence. Should the fence be erected in conformity with the order of the commission, no liability attaches for the injury or killing of the stock, unless the injury or killing was committed wilfully. (There are several bills pending before the Alabama Legislature, to amend this section of the Code, which have not yet been acted upon.)

Cattle-Guards.—The only statute with reference to cattle-guards is prescribed by section 3480 of the Code of 1896. Every person or corporation operating a railroad is required to put cattle-guards upon such railroad, and keep the same in good repair, whenever the owner of the land through which the road passes shall make demand upon them or their agents and show that such guards are necessary to prevent the depredation of stock upon his land. The particular kind of cattle-guard is not prescribed by law.

ARIZONA.

870. Section 110.—Every railroad corporation, in fencing its line or road, shall leave an opening at least once in every three miles, in an accessible place, for stock to pass through, and such opening to be at least one hundred feet wide, with cattle-guards at each end, and fences run to guards, so as to prevent cattle going onto the inclosed track, under penalty and liability as in the previous section provided.

879. Section 119.—Every railroad corporation shall construct and maintain good and sufficient crossings, where its railroad crosses public roads, or town streets, now or hereafter opened for public use, which crossings shall be constructed of the materials and in the manner following: On each side of each rail be laid a plank of not less than eight inches in width, and the remaining space between the rails shall be macadamized; on the outside of each rail there shall be a macadamized or gravel pavement of not less than six inches in depth and not less than four nor more than ten feet in width, to be determined by the road overseer, street commissioner or overseer, having such public road or street in charge; this pavement to be substantially and properly joined up to the plank provided to be laid on the outside of each rail. And every such corporation shall also cause boards to be placed, well supported by posts or otherwise, and constantly maintained, across each traveled public road or street where the same is crossed by railroad; said boards shall be elevated so as not to obstruct the travel, and to be

easily seen by the travelers, and on each side of such boards shall be painted in capital letters of at least the size of nine inches each, the words, "Railroad Crossing—Look Out for the Cars." If such corporation fail to construct and maintain said crossings or to put up boards as above provided, then the overseers, municipal authorities, or parties having legal control or charge of said road or streets, shall notify such corporation of the necessity for the construction thereof, which notice shall be in writing, and shall be served by delivering a copy of the same to the agent of the company most convenient to the crossing; upon the service of such notice, if such corporation fail to construct said crossings or put up said boards within sixty days from the service of said notice, the parties having control or charge of said roads or streets may proceed to construct said crossings or put up said boards as herein provided, and shall be entitled to recover the amount expended, together with all accruing costs, from such corporation thus refusing or neglecting to construct or put up the same; and such corporation shall be liable for all damages resulting from such neglect to construct such crossings or erect such sign boards as are hereby provided for; said damages to be recovered before any court having jurisdiction thereof, by civil action in the name of the parties injured or having legal control of said roads or streets. But in cities, towns, or villages, such sign boards shall not be required, unless the corporation shall be required to put up such boards by the officers having charge of such streets.

2651. Section 1.—Every inclosure shall be deemed under a lawful fence when the said fence is constructed as follows: All fences not less than forty-four inches high, consisting of boards firmly fastened to posts well set, not more than nine feet apart, the space between the ground and the bottom board shall not be more than fourteen inches, and other necessary boards shall not be more than ten inches apart, shall be considered lawful fence, and all fences forty-four inches high, consisting of four barbed wires, firmly fastened to posts well set, not more than thirty feet apart, with good stays extending from top wire to the ground, placed every six feet between the posts, each wire being firmly fastened to such stays, the bottom wire to be placed not more than fourteen inches from the ground, and the three other wires shall be ten inches apart from the bottom wire to the top of fence, and shall be deemed a legal and sufficient fence. When barbed wire is used for a fence a board or pole may be used in place of top wire when properly and securely fastened and stayed. All fences consisting of rails, timber, stone walls, brush hedge, adobe or other material which shall be equivalent to the board or barbed wire fence herein described, which shall be deemed a legal and sufficient fence.

3039. Section 65.—In all cases where the live stock of any person is injured or killed by locomotive or cars on any portion of the line of any railroad company within this territory, unfenced by good and sufficient fence, or other barriers sufficient to turn live stock, by the company or corporation running such locomotive or cars, shall be liable in damages therefor to the owner of such live stock, to be recovered in any court of competent jurisdiction within this territory, unless it be shown on the trial of any action instituted for the recovery of such damages, that the owner of such live stock, his agent or servants, immediately contributed to such killing or injury; the mere straying of live stock upon unfenced portions of such railroad shall not be held upon the trial of causes brought under this title to be any evidence of contributory negligence on the part of the owner of such live stock, nor shall the grazing of the same unattended by a herder be so considered.

3040. Section 66.—Every railroad corporation or company operating any railroad or branch thereof, within the limits of this territory, which negligently injures or kills any horse, mare, gelding, filly, jack, jenny, or

mule, or any cow, heifer, bull, ox, steer, or calf, or any other domestic animal, by running any engine or engines, car or cars, over or against any such animal, shall be liable to the owner of such animal for the damages sustained by such owner by reason thereof. The killing or injury shall be prima facie evidence of negligence on the part of such corporation or company.

3043. Section 69.—Any railroad corporation or lessee, person, company or corporation, operating any railroad in this territory which may hereafter fence their right-of-way, shall make crossings through their fence and over their roadbed along their right-of-way, at least every five miles thereof, or as near thereat as may be practicable.

3044. Section 70.—Such opening shall not be less than sixty feet in width. The said railroad company or lessee, person, corporation or company, operating any railroad shall place cattle-guards and wing fences on either side of the said openings, sufficient to prevent any cattle entering upon the said right-of-way so enclosed.

3045. Section 71.—Such railroad company, lessee, person or corporation operating any railroad, shall leave unfenced any places wherein the said railroad runs over any trestles or bridges that are sufficiently high for cattle to go under the same.

3046. Section 72.—Any railroad company, lessee, person or corporation operating any railroad in this territory, violating any of the provisions of the seven preceding sections, shall be deemed guilty of a misdemeanor, and, upon conviction thereof, shall in any court of competent jurisdiction be fined in a sum of not less than one hundred dollars and not more than three hundred dollars.

ARKANSAS.

There is no law in Arkansas compelling a railroad company to fence its right of way. The only thing in regard to cattle-guards is that, when a railroad company builds a line through an enclosed field, it shall put suitable and safe cattle-guards where they enter and where they leave said field. There is a penalty attached to this from $25.00 to $200.00 for each offense. Claim is to be proved in the Circuit Court.

CALIFORNIA.

Railroad corporations must make and maintain a good and sufficient fence on either or both sides of their track and property. In case they do not make and maintain such fence, if their engines or cars shall kill or maim any cattle or other domestic animals upon their line of road which passes through or along the property of the owner thereof, they must pay to the owner of such cattle or other domestic animals a fair market price for same, unless it occurred through the neglect or fault of the owner of the animal so killed or maimed. Railroad corporations paying to the owner of the land through or along which their road is located an agreed price for making and maintaining such fence, or paying the cost of such fence, with the award of damages allowed for the right-of-way for such railroad, are relieved and exonerated from all claims for damages arising out of the killing or maiming any animals of persons who thus fail to construct and maintain such fence; and the owners of such animals are responsible for any damages or losses which may accrue to such corporation from such animals being upon their railroad track, resulting from the non-construction of such fence, unless it is shown that such loss or damage occurred through the negligence or fault of the corporation, its officers, agents or employés.

This is the only statute requiring railroad companies to fence their tracks. There is no express statutory provision requiring cattle-guards.

It would probably, however, be held that by implication cattle-guards are necessary. The point has never been decided by the California Supreme Court. The California statutes do not attempt to describe just how the railroad fence shall be built. It has been held, however, that the fence must be of sufficient height, strength and form of construction to keep off the animals referred to in the statute. It will be observed that the animals mentioned in the statute are any "cattle or other domestic animals."

COLORADO.

Fences.—Every railway company operating in the state must fence its right of way, except at public road crossings and within the limits of incorporated towns and cities, and maintain such fences with gates therein at farm crossings. They must be of a character sufficient to prevent stock from getting on the right-of-way; and the failure so to fence makes the railway company liable for all damages for stock killed or injured. If such fences are built and properly maintained, the railway company is not liable for killing stock, unless the same is done negligently or wilfully.

Cattle-Guards.—All railway companies operating in the state must construct and maintain cattle-guards at all road crossings, sufficient to prevent stock from crossing over them. The failure so to do makes the railway company liable for the killing or damaging of all live stock that get on the right of way as a result of such failure.

Any land owner desiring to erect fences on his lands over which a railroad right of way runs, may build his fence to the line of such right of way, and serve notice on the railway company, whereupon it becomes the duty of the company to extend such fence across its right of way and insert cattle-guards. The land owner, however, must first deposit with the railway company a sum sufficient to cover the cost of such work; and the railway company, within ten days after application therefor, must furnish a statement of such cost. Failure to comply with the law entails a money penalty.

Colorado has no board of railroad commissioners or other officers fulfilling the duties ordinarily assigned to such commission.

CONNECTICUT.

Railroad companies are required to construct suitable cattle-guards and fences therefrom at all crossings of passways and highways to prevent cattle from passing upon the railroad, except when the railroad commissioners deem it unnecessary.

All railroads constructed under an act of incorporation prior to May, 1850, are required to erect and maintain fences at all places where directed by the railroad commissioners. All railroads under an act since that date are required to erect and maintain sufficient fences at all places, except where the railroad commissioners adjudge them unnecessary.

When requested, the railroad commissioners are required to investigate as to the necessity or condition of the fences on the line of a railroad, and when deemed necessary shall order the company to erect or repair such fences. The railroad company is required to comply under forfeit of $100 a month.

Anyone without neglect on his part suffering damage by neglect of railroad company to erect or maintain fences, as required by law, may recover his damage from the company.

Where it is the duty of the adjoining owner to erect or maintain a fence, and on his neglect the commissioners have required the railroad company to erect or maintain the same, the company may collect the cost from such owner, and the cost is a lien on the land.

Where neither the owner nor the railroad company can oblige the other to erect or maintain the fence, and the commissioners shall require it, the railroad company shall erect or maintain, and may collect one-half the cost from the adjoining owner.

A town opening a highway within one hundred yards of a railroad track may be required by a judge of the Superior Court to erect and maintain a fence between the highway and the railroad track.

Barbed wire prohibited within five feet of the ground along any sidewalk or public highway without written consent of the municipal authorities; also along the grounds of any public building; also within twenty-five rods of a house or barn belonging to an adjoining proprietor, without his written consent.

Anyone entering upon a railroad at a private way closed by gates or bars, and neglecting to close them securely, forfeits from $2 to $10.

DELAWARE.

Sec. 84.—Fences, Cattle-Guards, Etc.—Every corporation created under this act, for the construction of a railroad, shall erect and maintain fences on both sides of its road, of the height and strength of a fence required by law, with openings or gates or bars therein, at farm crossings of the road for the use of proprietors of lands adjoining such railroad; and shall construct and maintain cattle-guards at all road crossings suitable and sufficient to prevent cattle and other animals from getting on the railroad; and until such fences and cattle-guards shall be duly made, the corporation shall be liable for all damages which shall be done by their engines and cars to cattle, horses or other animals thereon; and after such fences and guards shall be duly made and maintained the corporation shall not be liable for any such damages unless negligently or wilfully done; and if any person shall ride, lead or drive any horse or other animal upon such railroad and within such fences and guards other than at farm crossings without the consent of the corporation, he shall for every such offense forfeit a sum not exceeding $10.00, and shall pay all damages which shall be sustained thereby to the party aggrieved; it shall not be lawful for any person other than those connected with or employed upon the railroad to walk along the track or tracks of any such railroad, except when the same be laid along public roads or streets.

FLORIDA.

Acts of 1899, Page 98, Chapter 4706.—The railroads in Florida are required to construct fences on both sides of their lines, suitable and sufficient to prevent the intrusion of any cattle, horses, hogs or other domestic live stock upon their tracks, but no fences are required within the limits of any incorporated town or city, unless provided by ordinance, and no fence shall be required within one mile of any city of ten thousand inhabitants or more.

That all fences inclosing railroads in Florida shall be substantially built, and shall be of such a kind as to prevent the intrusion of cattle, horses, hogs or other domestic live stock upon the tracks of said railroad, and there shall be left a space for road crossings, either neighborhood or public, at least 30 feet wide, with such stock-guards on both sides of such road crossing as will prevent cattle, horses, hogs and other domestic live stock entering upon such railroad enclosures. All such fencing from such live stock guards shall run at an acute angle with the railroad track to the main line of the fences and posts, and posts should be placed not more than eight feet apart for a distance of 60 feet from such stock-guards, and one board shall be placed on said post 12 inches from the earth, one thirty-six inches and one fifty-four inches from the earth, and

shall have such additional guards as may be necessary to make the fence suitable or sufficient to prevent the intrusion upon the tracks of any horses, hogs, cattle and other domestic live stock. There shall be such crossing and stock-guards constructed on all railroads passing through farms at such places as may be reasonably requested by the owner or owners.

Any railroad company, or person operating the same, failing to provide fences and stock-guards required by this act shall be liable for the full cash value of all cattle, horses, hogs or other domestic live stock killed or injured by any train upon the track of the railroad if the same be paid within thirty days after the presentation of the claim for damages, whether the same was killed or injured negligently or not, provided that upon failure to pay the claim within thirty days after presentation the road shall be liable for double the value of the animal killed or injured and for attorneys' fees.

That the fences and the stock-guard required by this act shall be retained and kept in good repair by the company or persons operating the railroad, so as to be at all times sufficient and suitable to prevent the intrusion of any cattle, hogs or other domestic live stock upon the track; and the failure to maintain the same, as aforesaid, shall subject the road to the same liability provided herein for failure to erect such fences.

When any stock is killed upon any railroad, the person entitled to damages shall present a claim to the railroad company in writing, and if the same is not paid within thirty days thereafter suit may be brought therefor. If the railroad shall tender or offer within thirty days the value of the stock killed or injured, which shall be found to be true value by the jury, the railroad company shall not be liable for double damages or attorneys' fees or costs, otherwise it will be. The provisions of the act do not provide log roads, and the action must be begun within one year from the accrual of the cause of action.

GEORGIA.

Fences.—There are a number of sections in Volume 1 of the Code of Georgia (1895) from section 1742 to 1788 inclusive, providing for an election on the question of fence or no fence, and providing that the boundary lines of each lot, tract or parcel of land, in any county or district, shall be declared a lawful fence where an election has been held, as provided in said sections and the result of said election shall be for stock-law.

What are known as stock-laws under sections 1742 to 1788 of the Code do not modify or alter the rule of diligence to be observed in the running of trains, but the existence of stock law in any locality is a fact which the jury may consider in ascertaining the amount of care and diligence exercised by each of the parties to the transaction, and in apportioning the extent of the liability of the company, if any. (71 Ga. 461, 87 Ga. 629.)

In Georgia, ordinary domestic animals and railroads trains are equally free, as respects each other, to pass over uninclosed lands. If they come into collision the damage to either, the diligence of their respective owners will become material on the question of compensation. (56 Ga. 540.)

Corporations are not bound to fence their lines; nor farmers to confine their ordinary domestic animals. (56 Ga. 542.)

That cattle go upon an uninclosed railroad track does not constitute the owner a trespasser.

Cattle-Guards.—(2243 Code of Georgia.) Every railroad company

shall be required to build and maintain at its own expense good and sufficient cattle-guards on each side of every public road or private way established pursuant to law, and on the dividing line of adjoining landowners where the railroad may cross such public roads, private ways, or dividing lines, when necessary to protect said lands. Thirty days' written notice to build such cattle-guards shall be served on any agent or officer of such company, by the owner of the lands to be affected by such cattle-guards; said notice shall be directed to said railroad company, and contain a description of the point where such cattle-guard is desired, be signed by the said landowner or his agent or attorney, and attested by some officer with a seal; a certified copy of the same being prima facie evidence of the contents of the original notice.

(2244 Code of Georgia.) If the railroad company shall fail to build such cattle-guards within thirty days, then the railroad company shall be liable to the owner of the land for all damages resulting from the failure so to build; and for each day elapsing after the thirty days have expired, until the said cattle-guard is built, in the sum of twenty-five dollars, to be recovered by said landowner in any court having jurisdiction over the same.

(2245 Code of Georgia.) Whenever the owner of any lands over which any railroad company may have acquired the right of way, may desire additional cattle-guards other than those provided for in the preceding section, or any farm crossing on his land, it shall be the duty of the railroad company, upon written notice as provided in the preceding section, within ten days after the service of the said notice, to submit to the landowner, or his agent, if to be found, a written estimate of the cost of such cattle-guard or farm crossing; whereupon the said landowner or his agent, if satisfied with the same, shall pay to the company the sum so estimated, when the company shall at once proceed to build such cattle-guards or farm crossing; the cost of the farm crossing to cover only the road-bed of the said railroad. In the event the landowner and the company cannot agree as to the correctness of the said estimate, then the same shall be determined in the same manner as damages for right of way. The award may be had at the instance of the landowner, or his agent, as well as at the instance of the railroad company. In the event the railroad company shall fail to comply with the provisions of this section, or to keep in good repair the guards or crossings, it shall be liable for all damages resulting to such landowner by the failure to build or keep in good repair such cattle-guards or farm crossings, to be recovered in any court having jurisdiction thereof.

(2246.) Nothing in the two preceding sections shall be construed in any way to change the liability of railroad companies for damages to live stock, or to prevent landowners from joining their fences to stock-gaps, or of free access from and to the said farm crossing. This and the two preceding sections shall not apply to any roads, ways or crossings within the limits of any incorporated town or city.

One in possession of land under bond for title, with part of the purchase money paid, is not the "owner" of such land within the meaning of section 2243-2246, imposing upon railroad companies the duties of erecting and maintaining cattle-guards at designated points along their line of road. (113 Ga. 357.)

Relatively to one who is not the owner of cultivated lands through which the track of the railroad company runs, such company is under no duty whether the notice provided for in the Code 2243-2246 be given by the owner or not to erect, keep or maintain cattle-guards, for the protection of crops growing upon such lands. For a breach of duty imposed by that statute the owner of the land only is entitled to maintain an action. (100 Ga. 600.)

In a suit against a railroad company by the landowner for a failure to erect cattle-guards, as required by section 2243-2246 of the Code, plaintiff must show upon trial that such cattle-guards were necessary to protect his land. Where the evidence shows there was no necessity for such cattle-guard prior to the time it was actually established by the company, verdict for plaintiff set aside. (104 Ga. 148.)

The law imposes upon a railroad company no duty to build and maintain at its own expense cattle-guards on its right of way except at public roads or private ways established pursuant to law, and on the dividing line of adjoining landowners, and suit demurrable unless it shows that cattle-guard in question was at one of the points in defendant's road above designated. (104 Ga. 603.)

The Railroad Commission of Georgia have nothing to do with cattle-guards, and the form prescribed by the statute of Georgia for the same is to be found in Code section 2243, et. seq. as supra.

IDAHO.

Section 2186 of the Civil Code (Annotated) provides that railroad corporations must make and maintain a good and sufficient fence on either or both sides of their track or property whenever the line of road passes through, or is contiguous to, private property or enclosed land in the actual possession of another.

The law does not prescribe any particular kind of fence; and cattle-guards are not mentioned. The courts have held that a cattle-guard is necessarily a part of a sufficient fence; and that this provision of law is for the benefit of the owners of stock as well as for the owners of land.

ILLINOIS.

Chapter 114, Section 62, Starr & Curtiss Annotated Statutes, provides that a railroad company shall within six months after its line is open for use maintain fences on both sides of its road, or so much thereof as is open for use, suitable and sufficient to prevent cattle, horses, sheep, hogs or other stock from getting on such railroad, except at the crossings of public roads and highways, and within such portions of cities and incorporated towns and villages as are or may be hereafter laid out and platted into lots and blocks, with gates or bars at the farm crossings of such railroad, which farm crossing shall be constructed by such corporation when and where the same may become necessary, for the use of the proprietors of the lands adjoining such railroad.

Such railroad shall maintain at all road crossings now existing or hereafter established cattle-guards suitable and sufficient to prevent cattle, horses, sheep, hogs and other stock from getting on such road.

The Railroad and Warehouse Commission of Illinois has, under the statute, the powers ordinarily assigned to such Commission, but does not appear to have authority to pass upon cattle-guards, or to decide whether any cattle-guard meets the requirements of the State statute.

INDIANA.

Section 5323, Revised Statutes, provides that railroad companies shall within twelve months from the date of the construction and completion of any part of the line of railroad construct and thereafter maintain fences, which may be constructed of barbed wire, on both sides of such railroad throughout the entire length, sufficient and suitable to turn and prevent cattle, horses, mules, sheep, hogs or other stock from getting on such road, except at the crossings of public roads and highways and

within such portions of cities and incorporated towns and villages as are or may hereafter be laid out and platted into lots and blocks.

Shall construct and maintain at all public road and highway crossings now existing, or hereafter established, barriers and cattle-guards suitable and sufficient to prevent cattle, horses, sheep, hogs and other stock from getting on such railroad.

Railroad companies are not required to fence the railroad track through unimproved and uninclosed lands, but, when such lands become improved and enclosed on three sides, the statute relating to fences and cattle-guards shall apply.

INDIAN TERRITORY.

The Indian Territory has no laws in regard to fencing right-of-way of railroads. The Indian Territory is under Federal Laws. Part of the statutes of Arkansas are extended to apply to the Indian Territory. None of the statutes compelling railroads to fence their right-of-way in Arkansas have been included in those statutes that are applicable to this territory.

IOWA.

In Iowa all railway corporations owning or operating a line of railway within the state shall construct, maintain and keep in repair a suitable fence of posts and barbed wire, or posts and boards, or any other fence which the fence viewers shall determine to be equivalent thereto, on each side of the track thereof, so connected with cattle-guards at all public crossings as to prevent cattle, horses and other live stock from getting on the railroad tracks. Such tracks shall be fenced within six months after the completion of the same, or any part thereof. Such fences, when of barbed wire, shall be of five wires, securely fastened to posts set not more than twenty feet apart, the top wires to be not less than fifty-four inches high; or of five boards securely nailed to posts set not more than eight feet apart, the fence to be not less than thirty-four inches high. Fences repaired or rebuilt shall conform to the foregoing provisions.

A railway company is not, however, required to fence at depot or station grounds, where it would not, in view of public convenience, be fit, proper or suitable to do so, and such depot and station grounds may be left unenclosed when the business of the road and the interests of the public require.

Nor is the company required to fence where its track crosses a public highway, nor across platted streets or alleys within city or town limits, even though such streets or alleys are not opened or used, but has the right to fence within the corporate limits of a town so far as its line runs through lands situated beyond streets or other highways.

A failure or refusal to so fence constitutes a misdemeanor, and, upon conviction, the company so neglecting may be fined in a sum not exceeding $500 for each fence, and every thirty days' continuance of such refusal or neglect shall constitute a separate and distinct offense.

The application of this law is practically the same as in the state of Minnesota, viz., the railway company being required to fence against all kinds of stock.

KANSAS.

Fences.—Every railroad company is made liable to the owner of every animal killed or injured by the engine or cars of such railway, or in any manner whatever in operating such railway, irrespective of the

fact as to whether such killing or wounding was caused by the negligence of such company or not. (Par. 5859, Gen. Stat. 1901.)

This act, however, does not apply to any company whose road is inclosed with a good and lawful fence. (Par. 5863, Gen. Stat. 1901.)

Where any person owning land adjoining or through which any railroad is constructed shall inclose his land with a lawful fence or a hog-tight fence, he may demand that such railway company shall inclose its line next thereto with a lawful fence or hog-tight fence and maintain the same. (Par. 5919, Gen. Stat. 1901.)

If a railway company fails to so inclose its right-of-way the land owner may serve written notice upon the company so to do within sixty days (except during the months of December and January) after the service of such notice, and in case of refusal the land owner may then construct such fence and recover from the railway company the cost thereof, together with a reasonable attorney's fee for the prosecution of a suit to recover the same. (Pars. 5920, 5921, Gen. Stat. 1901.)

Any person owning lands adjoining a railroad track has the right to attach to the fence constructed along the right-of-way of said railroad company rails, boards or other material so as to make the fence of said railway company sufficient to prevent hogs or pigs from going upon the track of said railroad. (Par. 5922, Gen. Stat. 1901.)

A legal fence is defined by statute as follows:

All fences composed of posts and rails, posts and palings, posts and planks, or palisades, or of stone, or composed of posts and wires, or those composed of turf, shall be at least four feet high. Those composed of rails, commonly called a worm fence, shall be at least four feet and one-half high to the top of the rider, and shall be thoroughly staked and ridered, or if not staked and ridered shall have the corners locked with strong rails, stakes or posts. Those composed of stone shall be at least eighteen inches wide at the bottom and twelve inches wide at the top. Those composed of turf to be thoroughly staked and ridered, and shall have a ditch on the outside not less than two feet wide at the top and three feet deep. All fences composed of rails or lumber, the bottom rail, board or plank shall not be more than two feet from the ground in any township, and in those townships where hogs are not prohibited from running at large it shall not be more than six inches from the ground; and all such fences shall be substantially built and sufficiently close to prevent stock from going through. All hedge fences shall be of such height and thickness as will be sufficient to protect the field or inclosure. (Par. 3072, Gen. Stat. 1901.)

In fences composed of posts and wires, the posts shall be of ordinary size for fencing purposes, and set in the ground at least two feet deep and not more than twelve feet apart, with holes through the posts or staples on the side not more than fifteen inches apart, to admit four separate strands of fence wire not smaller than No. 9, and shall be provided with rollers and levers, at suitable distances, to strain and hold the wire straight and firm. (Par. 3073, Gen. Stat. 1901.)

That in addition to the fence now declared by law to be a legal fence, the following shall be a legal fence: A barbed-wire fence, of not less than three wires, with third wire from the ground not less than forty-four inches nor more than forty-eight inches from the ground, and bottom wire not more than twenty-four inches nor less than eighteen inches from the ground, with center wire equidistant, or nearly so, between upper and lower wires; said wires to be well stretched and barbed, barbs to average not more than nine inches apart; said barbed wire to be composed of two wires not smaller than No. 13, or one wire not smaller than No. 9, wires to be securely fastened to posts, which shall not be more than two rods apart and not less than twenty inches in the ground, and set in

a workmanlike manner; or the posts may be not more than forty-eight feet apart, with slats placed perpendicularly, not more than twelve feet apart, between the posts, and fastened to the wires by staples, or with holes in the slats. Provided, that in townships or counties where hogs are allowed to run at large, there shall be three additional barbed wires, the lower one of which shall not be more than four inches from the ground, the other two to be placed an equal distance apart, or nearly so, between this and the lower wire as required above. (Par. 3075, Gen. Stat. 1901.)

Cattle-Guards. When any railroad runs through any improved or fenced land, such railroad company shall make proper cattle-guards on such railroad when they enter and when they leave such improved or fenced land. (Par. 586¢, Gen. Stat. 1901.)

And the company is made liable for all damages sustained by anyone by reason of its neglect or refusal to construct and maintain such cattle-guards. (Par. 5867, Gen. Stat. 1901.)

A judgment for damages for such neglect is made a lien upon the railroad property, prior and superior to the lien of any mortgage or trust deed or other liens except lien for taxes. (Par. 5868, Gen. Stat. 1901.)

Railroad Commissioners.—Kansas has a board of railroad commissioners, who have general supervisory powers over railroads, and especially tariffs, but there is no special provision giving any authority over either fences or cattle-guards, and it was not contemplated that they should have jurisdiction and supervision of the construction or maintenance of either.

KENTUCKY.

Sec. 1789, Ky. Stat., Act of Feb. 25, 1893.—Railroad corporations, or any person owning or controlling a railroad and owning the right-of-way, and the railroad has been constructed and in operation for a period of five years, the same is put on equal terms with other land owners owning adjoining lands in the commonwealth.

Sec. 1790, Ky. Stat., Act of Feb. 25, 1893.—Every such corporation in the Commonwealth owning its right-of-way, and which has been in operation for a period of five years, shall construct and maintain a good and lawful fence on one-half of the distance of the division line between such right-of-way and the adjoining lands, except as hereinafter stated, and every owner of land adjoining such rights-of-way of such corporation, or person owning or operating such railroad, shall construct and maintain a good and lawful fence on one-half of the distance of the division line between such land or lands, and such rights-of-way, except as hereinafter stated.

Sec. 1791, Ky. Stat., same act, same date.—Whenever the corporation, or person owning or controlling and operating the railroad, or the owner of the lands adjoining the right-of-way thereof, has constructed a good and lawful fence on the adjoining line between such right-of-way and the lands adjoining same for one-half the distance of such line, and the other party has not constructed such fence on said line for one-half the distance, or has paid a sum sufficient to construct such fence, or any sum by agreement in lieu thereof, the party who has constructed such fences shall notify the party in default in writing of the length of the division line between them, and that he, the party serving such notice, has constructed a good and lawful fence on such division line for one-half the distance, it is, then, the duty of the party on whom such notice is served, and he is required to construct a good and lawful fence on the other one-half of the distance of such dividing line within four months after the date of receiving such notice. If the corporation is in default,

such notice may be served on its nearest station agent, and if the party on whom such notice is served fails to construct such fence within the said four months, such party so in default shall be fined one dollar—$1—for each and every day after the expiration of such period of four months, during which time said fence shall not have been constructed, and these fines are recoverable by warrant in the name of the Commonwealth of Kentucky before any court of competent jurisdiction.

Sec. 1792, same act, same date.—This law, however, does not apply in any case where the corporation or person owning or controlling and operating the railroad has furnished the material to construct a fence, or has condemned its right-of-way and paid the owner, or his vendor, damages, in the estimation of which damages the cost of fencing was taken into consideration. Nor does it require such railroad company to build any fence along the line through any town or city, or across any public or private passway; nor through unimproved or uncultivated lands, until the owner of such lands shall have previously enclosed such lands on three sides with sufficient fence, or unless such lands be so enclosed with fencing, or a river, creek, bluff, or such other natural barrier as will prevent the egress of such stock.

Sec. 1794, same act, same date.—Any landowner, who has already built a lawful fence along the whole distance along the division line between his land and the right-of-way of any railroad, shall have the right, in the absence of any agreement to the contrary, after giving three months' notice to the corporation, to be served on the nearest station agent, of such intention, to move one-half of the fence; he shall not, however, in removing such part of his fence, cause such corporation to erect water gaps, and to fence at such points where the grade of the roadbed is of such character as may make fences unnecessary.

Sec. 1795, same act, same date.—A lawful fence within the meaning of this law, is any fence constructed of substantial posts, well set, not less than two feet in the ground, and at no greater distance apart than ten feet, with wire not less than 4½ feet high, consisting of seven strands, but nothing in this act prevents parties from erecting any other class of lawful fence.

Sec. 1796, same act, same date.—This act in regard to fences of railroads does not apply to any land where the owner, or his vendor, has received compensation for fencing the same.

Sec. 1797, same act, same date.—The railroad company shall erect the entire fence when the owner of any land or lands, or any immediate or remote grantor, or vendor, of said owner has given to the corporation or person owning or controlling and operating any railroad a right-of-way through said land free of charge. This section has been held to be unconstitutional by Court of Appeals of Kentucky. See 91st Kentucky, page 175.

Sec. 1798, same act, same date, Feb. 25, 1893.—Nothing in this shall be construed, or can be construed as preventing corporations, or persons owning or controlling and operating railroads and owners of lands adjoining such rights-of-way from entering into contracts for the construction of fences of the character contemplated by this act. A lawful fence constructed under such contracts shall be a sufficient compliance with the provisions of this act.

Sec. 1799, same act, same date, Feb. 25, 1893.—Where two railroad companies adjoin lands or rights-of-way, or a railroad company and turnpike company adjoin lands or rights-of-way running parallel with any tillable or grazing lands between their rights-of-way, the railroad company shall not be required to build any fence along its side next to said pike or railroad, unless the turnpike or other railroad company has first built its half along said division line.

CATTLE-GUARDS.—Sec. 1793, act of Feb. 25, 1893.—All corporations and persons owning and controlling and operating railroads in the Commonwealth of Kentucky, are required to erect and maintain cattle-guards at all terminal points of fences constructed along their line, unless at points where such lines are not required to be fenced on both sides, and at public crossings, but where there is a private passway across said railroad, the landowner for whose benefit it is kept open shall bear one-half of the expense of cattle-guards and gates, the owner of the said premises to erect the gates, and the corporation or person operating the railroad to erect the cattle-guards.

The company is only required to erect cattle-guards at crossings at points where the fencing on both sides of the road for any reason stops so that the fencing and the cattle-guards will close in the track—that is, fences on both sides, it is not required to erect guards at points that are dividing lines between the lands of adjacent owners.

Neglect on the part of the company to erect and keep in repair suitable cattle-guards renders it liable for injuries to cattle getting on the track, by reason of such failure.

LOUISIANA.

There is no statute in Louisiana requiring railroad companies to fence their property, nor is there any statute in that State relative to cattle-guards. The only reference to fences and cattle-guards in the statutes of Louisiana, so far as railroads are concerned, is found in Act No. 110 of 1886, in the shape of a proviso to section 3, as follows:

"Provided, further, That there shall be no responsibility on the part of railroad companies for killing or injury of stock where said railroad companies have their line of track fenced in and kept in good order, and have erected and maintained, in good order, suitable cattle-guards at crossings."

There is a Railroad Commission in Louisiana, organized under the Constitution of 1898, Articles 283 to 289, both inclusive.

The Commission has no rule relative to, and has never undertaken to legislate about, signs, fences or cattle-guards. The nearest approach to any regulation of the railroads by the Commission in this respect is to be found in Article 284: "And to inspect railroads and require them to keep their tracks and bridges in a safe condition."

MAINE.

RAILROAD COMMISSIONERS.—A board of three railroad commissioners, one a lawyer, one an engineer and the third experienced in railroad matters, is to be appointed by the Governor with the consent of the council. They do not seem to have jurisdiction over fences or cattle-guards except that they must report to the Governor facts of public interest.—Revised Statutes, chapter 51, paragraph 114.

FENCES.—Where a railroad passes through inclosed or improved land, or woodlots belonging to a farm, legal and sufficient fences shall be made on each side of the land taken therefor, before the construction of the road is commenced, and such fences shall be maintained and kept in good repair by the corporation. Directors are personally liable for injuries because of neglect to do so during construction of road; for neglect afterward the corporation is to be fined enough to construct or repair fence and the fund will be expended by agent of court. After thirty days' notice by an owner of land above mentioned, if corporation neglects to build or repair a fence complained of it forfeits $100 to such owner. Revised Statutes, chapter 51, paragraphs 36-37.

All fences four feet high and in good repair, consisting of rails, timber, boards, stone walls, iron or wire; and brooks, rivers, ponds, creeks, ditches and hedges, or other things which, in the judgment of the fence viewers having jurisdiction thereof are equivalent thereto, are legal and sufficient fences; provided, however, that no barbed wire fence shall be accounted legal and sufficient unless it is protected by an upper rail or board of wood. Revised Statutes, chapter 22, paragraph 1, as amended 1887, chapter 15.

CATTLE-GUARDS.—County commissioners, when land is taken for railroad, shall order the corporation to make and maintain such cattle-guards, cattle passes and farm crossings as they think reasonable, prescribe the time and manner of making them, and consider this work in awarding pecuniary damages for the land so taken. Supreme judicial court has jurisdiction in equity to enforce such orders. Revised Statutes, chapter 51, paragraph 21.

MARYLAND.

The laws of the State of Maryland are commonly divided into two classes, Public General Laws and Public Local Laws. The first class of laws applies to the whole State, the second class of laws have application only to the counties of the State named in the acts. There is no Public General Law in the State of Maryland in regard to cattle-guards or fences in connection with railroads, but all railroad companies are expressly made liable for injuries inflicted upon stock, such as cattle, horses, sheep, hogs, etc.

Public General Laws of Maryland—Article 23.—Sec. 198.—Railroad companies shall be responsible for injuries resulting in death or otherwise, inflicted upon any stock, as cattle, horses, sheep, hogs, and so forth, or by fire occasioned by their engines or carriages, upon any of their roads and the branches thereof, unless the said companies can prove, to the satisfaction of the justice or other tribunal before which the suit may be tried, that the injury complained of was committed without any negligence on the part of the company or its agents.

Sec. 199.—The damages caused by such injuries may be sued for and recovered by the owner of such stock, or the person injured by fire, before a justice of the peace, when the damages claimed shall not be over one hundred dollars, and in the circuit court for the county or the courts having civil jurisdiction over the amount claimed in the City of Baltimore, when the amount claimed exceeds one hundred dollars.

Sec. 200.—The damages claimed under section 198 of this article shall be sued for in the county or city where the injuries shall have been done; and a summons served upon the president, or any of the directors or conductors of any of said companies, shall be considered proper service upon the corporation; provided, said service shall be made at least twenty days before the return day of the writ.

Sec. 201.—If the company summoned shall not appear to answer at the time named in the summons, on the return of two summons served as aforesaid, the court or justice shall proceed to enter up judgment against said corporation as if the said corporation had regularly appeared; but such judgment shall not be rendered until affidavit shall be filed showing the name of the president, director or conductor on whom said service was made, and the day of said service; and any property belonging to the corporation shall be liable to execution for the amount of such judgment.

In regard to the Public Local Laws, there are almost as many different fence laws relating to fences of enclosures and division fences as there are counties in the State, but none of them are specially applicable to railroads with the sole exception of that of Worcester County, which is as follows:

Public Local Laws of the State of Maryland, Title Worcester County, Article 24.—Sec. 219.—It shall be the duty of all railroad companies whose lines pass through and are operated in Worcester County to construct and keep in good order cattle-guards wherever such railroads shall pass through any enclosed lands, at the points where fences now exist, or may hereafter become necessary upon such land, as may be agreed upon between such railroad companies and the owner of such land; provided, in case of any disagreement between said parties, then such differences shall be ascertained and fixed by three disinterested land owners, to be appointed by the circuit court, upon the application of the land owner, after ten days' notice to the railroad companies, whether they be dividing places between contiguous farms or fences along the public highways, or division fences belonging to the owners of the farms; said cattle-guards shall be of sufficient length and width to prevent the passage of stock of all kinds, and shall be constructed on the request in writing of any land owner interested therein, made to the agent of the company who shall have charge or supervision of the road at that point; and in addition to said cattle guards, such railroad companies shall cause to be built and kept in good order a lawful fence on each side thereof, and extending sixteen feet from the cattle-guard, to which the land owner shall have the right to join his fence; provided, that no land owner shall be in any way liable, either directly or indirectly, to the railroad company or any person whatever, for any damage or injury which may occur or result from the construction of his fence over the company's land, which may be necessary to connect his fence with that of the company's.

Sec. 220.—For any failure to comply with any of the provisions of the preceding section, the company so failing for sixty days after such written request, shall forfeit and pay to the party injured, five dollars for each day's failure thereafter, to be recovered as other debts are now collected by an action before a justice of the peace, or the circuit court, when the amount is such as will give such circuit court jurisdiction; said notice or request may be served upon an agent of the company.

MASSACHUSETTS.

The references are to the Revised Laws of Massachusetts (1902).

Chapter 33, section 1: Fences four feet high, in good repair, constructed of rails, timber, boards, iron or stone; or brooks, rivers, ponds, creeks, ditches and hedges, or other things which the fence viewers consider equivalent thereto, are deemed legal and sufficient fences.

Chapter 53, section 4: Barbed wire fences prohibited within six feet above the ground along sidewalks on public way.

Chapter 111, section 106: After a railroad corporation has taken land it shall before constructing road, if requested by owner or occupant, fence it.

Chapter 111, sections 118-121: The county commissioners, when estimating damages to land owners caused by taking of lands for a railroad, may order the construction of such fences as they judge reasonable for the security and benefit of the owner. The corporation may be compelled to comply with such order by the Supreme Court, or the person interested may recover double damages sustained by reason of the neglect to comply.

Every railroad corporation is required to erect and maintain suitable fences on both sides the entire length of its railroad, except where impracticable, and except at places where and so long as it is specially exempted from so doing by the board of railroad commissioners.

The corporation shall also construct and maintain sufficient barriers, where it is necessary and practicable so to do, to prevent the entrance of cattle upon the road.

The corporation, for unreasonable neglect to comply with the provisions of the two preceding paragraphs, is liable to a forfeit not exceeding $200 per month of such neglect, and may be compelled to comply with the provisions by the Supreme Judicial Court.

At any point where a person other than the corporation is required by law or contract to maintain a fence, and fails so to do, the corporation is required to erect and maintain such fence, and may recover the cost from such person. If the latter is the owner of adjoining land, the corporation has a lien on the land.

Anyone entering upon a railroad at a private way closed by gates or bars, and neglecting to close them securely, forfeits from $2 to $10.

MICHIGAN.

Howell's Annotated Statutes, Section 3377, provide that railroad companies shall erect and maintain in effective condition of repair fences on each side of the right-of-way of their respective roads. * * * A legal railroad fence shall not be less than four and one-half feet high, and shall be made of boards and posts in combination as follows: The boards to be of pine or hemlock, six inches in width and sixteen feet in length; the posts to be of cedar, tamarack or oak, not less than seven feet in length and five inches in diameter, to be set not less than two and one-half feet in the ground, at a distance apart not more than eight feet from center to center. First a board shall be nailed to the posts close to the ground; five inches above such first board a second; six inches above the second a third; six inches above the third a fourth; six inches above the fourth a fifth; all to be capped with a like board securely nailed to the fifth board and to the posts. Or it may be constructed of posts, boards and wire in combination, with posts of cedar, tamarack or oak seven feet in length and five inches in diameter, two and one-half feet in the ground, and eight feet from center to center.

For detailed description of other kinds of fences see statute above referred to.

The same section provides that such right-of-way fences shall be provided with suitable connecting fences and cattle-guards at all highway and street crossings, which shall at all times be kept in effective repair and sufficient to prevent stock of all kinds from passing upon the track of the railroad. Convenient farm crossings shall also be constructed across the right-of-way with necessary gates or bars as the owner or occupant of the premises may elect.

For details as to construction see above statute.

MINNESOTA.

Section 2692. Fences and Cattle-Guards.—All railroad companies in this State shall, within six months from and after the passage of this act, build or cause to be built good and sufficient cattle-guards at all wagon crossings, and good and sufficient fences on each side of such road.

The application of this law has been variously construed by the courts, but in effect it requires the railroad company to construct a fence which will turn either hogs or cattle.

MISSISSIPPI.

There is no statute in Mississippi requiring the fencing of railroad property.

The statute concerning cattle-guards is as follows: "Stock Gaps and Cattle-guards. It is the duty of every railroad company to con-

struct and maintain all necessary or proper stock-gaps and cattle-guards where its track passes through enclosed land; and to make and maintain convenient and suitable crossings over its track for necessary plantation roads. For any failure so to do, the railroad company shall be liable to pay two hundred and fifty dollars, to be recovered by the person interested." (Sec. 3561, Code of Miss., 1892.)

There is a Railroad Commission, but it is not within the jurisdiction of the Commission to pass upon or prescribe any form of cattle-guard, and a compliance by the railroad company with any order which the Commission might make concerning a particular form of cattle-guard would be no protection to the company. Its liability would depend upon whether it had "constructed and maintained all necessary or proper stock-gaps and cattle-guards."

MISSOURI.

DIGEST—FENCES.—By section 1105 railroad companies are required to fence their roads for two purposes; one to prevent stock from straying onto its tracks, and the other to prevent stock from trespassing upon the adjacent fields. Kingsbury v. Missouri, Kansas & Texas R. Co., 156 Mo., 379.

Section 1105 does not require that the fences shall be sufficient to prevent animals from getting on the railroad; the only requirement is that they shall be lawful fences. Dietrich v. Hannibal & St. J. R. Co., 89 App. 36.

Where the fence is erected over the bed of a creek full of water, which, by evaporation and absorption, disappears and leaves a space beneath the bottom wire sufficient to admit cattle, such fence is insufficient under the statute. Selders v. Ry. Co., 19 Mo. App. 334.

No action can be maintained under section 1105 for stock killed or injured within the corporate limits of cities or towns. Meadows v. Chicago, Milwaukee & St. Paul R. Co., 82 App. 83.

A railway company is not required to fence its tracks and put in cattle-guards at necessary switches when to do so would endanger the safety of its employes. Glasscock v. Missouri, K. & T. R. Co., 82 App. 146; Ellis v. Miss. Riv. & B. T. R. Co., 89 App. 241; Hurd v. Chappell, 91 App. 317.

Though it is the duty of the company to construct and maintain suitable fences along its line, and gates at farm crossings, yet it is not an insurer of the sufficiency of the fences and gates at all times; it is its duty to exercise a suitable degree of care to keep such fences and gates in the same substantial condition they were in when first properly constructed. Atchison, T. & S. Fe R. Co. v. Kavanaugh, 163 Mo. 54.

If a defect should occur in either, of which the company had no actual notice, and which had not existed for such a length of time as, in contemplation of law, to impute notice to the company, it would not be liable. Atchison, T. & S. Fe R. Co. v. Kavanaugh, 163 Mo. 54.

Where, at the very farthest, only a few hours could have elapsed from the time the gate was left open by some unknown person until it was discovered to be open the next morning, this length of time is not sufficient to impute notice to the company. Atchison, T. & S. Fe R. Co. v. Kavanaugh, 163 Mo. 54.

A railroad company is entitled to a reasonable time to ascertain that its fence is out of repair; and also, to a like reasonable time after such knowledge to make repairs. And the instructions should so inform the jury. Colyer v. Missouri Pac. R. Co., 93 App. 147.

If such is killed or injured where the right-of-way is not inclosed by a lawful fence, the owner may recover double damages if the loss

occurred by the failure to fence where required by section 1105, or may recover single damages under section 2867, whether the failure to fence was at a place required by section 1105, or was at a place not so required, but which might lawfully have been fenced. Meadows v. Chicago, Milwaukee & St. Paul R. Co., 82 App. 83.

Section 2867 provides for an action not only when the injury occurs at a point required to be fenced, but at any point on the road where the railroad company may lawfully fence its track. Meadows v. Chicago, Milwaukee & St. Paul R. Co., 82 App. 83.

Section 2867 does not require companies to fence their roads; it simply dispenses with proof of negligence if animals are killed where there are no fences, and where they might lawfully have been erected. Edwards v. Han. & St. J. R. Co., 66 Mo. 567.

The obligation of a railway company to maintain openings and gates in its fences exists, under section 1105, not at all farm crossings, but only at those which are necessary. Whether a crossing is necessary for the purposes of a statute is a mixed question of law and fact. Miller v. R. R. Co., 56 Mo. App. 72.

As the law stands, railroad companies are required to inclose their roads with a lawful fence at all points outside of incorporated towns, except at public road crossings and about their railroad stations. It follows that there is now no place (at least outside of incorporated towns and cities, where the roads may fence) where they are not also required to fence. Boyle v. Ry. Co., 21 Mo. App. 418.

A railway company is not required to fence such grounds as the use of the public and the necessary transaction of business at its depot or station require to remain open. Vandeworker v. Ry. Co., 51 Mo. App. 166; Crenshaw v. Ry. Co., 54 Mo. App. 233.

But this does not apply to the mere switch room at the station. (Morris v. R. R. Co., 58 Mo. 78.)

The rule is that, though the point of injury is within switching grounds, and though such grounds be used in connection with a depot or station, the railroad company must, nevertheless, erect and maintain fences and cattle-guards, unless such fences would interfere with the transaction of business. Chouteau v. R. R. Co., 28 Mo. App. 556.

When a railroad switch is crossed by a public road, the railway company is prevented thereby from fencing the entire switch, and therefore is not bound to fence any portion of it. Wright v. Ry. Co., 56 Mo. App. 367.

The meaning of the statutory requirement in section 1105 that railroad companies shall erect and maintain fences, with gates and bars, etc., is that railroad companies shall maintain the gates closed. The gates are a part of the fence; and the duty to keep the fences in repair includes the duty to keep them safely and securely closed, so as to afford protection from stock getting on the road through the gates. For a railroad company to permit such a gate to remain open when it knows, or by ordinary care might know, that the gate is open, is negligence under the statute, and is a failure to erect and maintain the gate under the statute. Woods v. R. R. Co., 51 Mo. App. 500.

When a gate is properly erected by the company, it is the duty of the landowner after using it to see that it is closed; and if his stock is killed or injured by reason of his failure to do so, the company is not liable. Box v. Ry. Co., 58 Mo. App. 359.

CATTLE-GUARDS.—The statute has defined what shall constitute a lawful fence, but it has not in terms defined a cattle-guard, further than that it shall be sufficient to prevent horses, cattle, mules and other animals from getting on the railroad. It was certainly not the intention of the legislature to require that a cattle-guard must be so constructed and

maintained as to interpose an absolutely insurmountable and impassable barrier against the encroachment of stock, without exception and under all circumstances. Cole v. R. R. Co., 47 Mo. App. 624.

Where fences running alongside the track, and cattle-guards in the track, are required to prevent cattle from getting on the roadbed, cross fences are necessary parts of such cattle-guards, in order to make the inclosure effectual. Edwards v. R. R. Co., 74 Mo. 117.

Section 1105 only requires such a cattle-guard as is ordinarily or usually sufficient to prevent stock from crossing it; and a jury called to try the sufficiency of a cattle-guard should so be informed by the instruction. Cole v. Ry. Co., 47 Mo. App. 624; Jones v. Ry. Co., 59 Mo. App. 137.

When a railway company has a switch and transfer track at a station, it is not bound under the statute to erect a cattle-guard nearer to the apex of the switch than can be done without materially interfering with its business, and without endangering the lives of its employes. Grant v. R. R. Co., 56 Mo. App. 65.

The statute does not require the construction of either cattle-guards or cross fences at farm crossings. Fitterling v. Ry. Co., 79 Mo. 504; Dent v. Ry. Co., 83 Mo. 496.

There is a board of railroad and warehouse commissioners in Missouri, but under the law creating such board no jurisdiction is given it to pass upon any form of cattle-guard.

Under section 1205, R. S., 1899, jurisdiction is given the board to inspect tracks, bridges and other structures, with a view to securing the safety of passengers, etc., and in the exercise thereof it might become proper under some circumstances for it to direct the construction of cattle-guards, although such structures are defined by statute, section 1105, and unless that requirement were violated in such a manner as to endanger passengers, it would seem that the board is without jurisdiction of the subject.

The board, it would seem, is without power to pass upon the form of a cattle-guard so as to preclude a test of its sufficiency under the requirements of the statute.

MONTANA.

Railroad companies must make and maintain a good and sufficient fence on both sides of their track. If they fail to do so, they shall be liable to owners of cattle killed or injured by reason of such failure for the fair market price of the cattle killed, and for the damages to those injured. Railway companies may pay the owner of the land for maintaining the fence, in which event they are relieved of the duty.

When railway companies fence their right-of-way they shall construct crossings through the fence and over the tracks every four miles. These crossings shall be not less than sixty feet wide and there shall be placed at the crossing sufficient cattle-guards to prevent cattle from entering upon the right-of-way.

NEBRASKA.

Fencing and Cattle-Guards.—Section 4012.—That every railroad corporation whose lines of road or any part thereof are open for use, shall, within six months after the passage of this act, and every railroad company formed or to be formed, but whose lines are not now open for use, shall, within six months after the lines of such railroad or any part thereof are open, erect and thereafter maintain fences on the sides of said railroad, or the part thereof so open for use, suitably and amply sufficient to prevent cattle, horses, sheep and hogs from getting on said railroad,

except at the crossings of public roads and highways, and within the limits of towns, cities and villages, with opens, or gates or bars at all the farm crossings of such railroads, for the use of the proprietors of the land adjoining such railroad, and shall also construct, where the same has not already been done, and hereafter maintain at all road crossings, now existing or hereafter established, cattle-guards suitable and sufficient to prevent cattle, horses, sheep and hogs from getting on to such railroad.

(Then follows provision as to erection by adjoining landowners at cost of railroad of a fence upon his land upon failure of railroad to erect same after six months' notice.)

NEVADA.

Section 1011 of Compiled Laws of Nevada, Edition of 1900, reads as follows:—

1011: Section 40.— * * * * It shall be the duty of the railroad company to make and maintain a good and sufficient fence on either or both sides of their property; and in case any company do not make and maintain such fence, if their engine or cars shall kill, maim, or destroy any cattle, or other domestic animals, when they stray upon their line of road, where it passes through or alongside of the property of the owners thereof, they shall pay to the owner or owners of such cattle, or other domestic animal, a fair market price for the same, unless the owner or owners of the animal or animals so killed, maimed or destroyed shall be negligent or at fault. In any case, where the railroad company have heretofore, or may hereafter, pay to the owner or owners of the land, through which, or alongside of which, their road is or may be located, an agreed price for making and maintaining such fence, or whenever the cost of such fence has been or may be included in the amount of damages allowed and paid for the right-of-way for such railroad, such company shall be entirely relieved and exonerated from all claims and awards of damages arising out of the killing or maiming any animals, as aforesaid, in favor of all persons, or their successors or assigns, who shall thus fail to construct and maintain such fence. And the owner or owners of such animals shall become responsible to the railroad company for any damage or loss which may accrue to such company from such animals being upon their railroad track, by reason of the non-construction of such fence by said owner, unless it can be proven that such loss or damage accrued by reason of the negligence of such company, its officers, agents, or employés.

This is the only statute requiring railroad companies to fence their tracks. There is no express statutory provision requiring cattle-guards. It would probably, however, be held that by implication cattle-guards are necessary. The point has never been decided by the Nevada Supreme Court. The Nevada statutes do not attempt to describe just how the railroad fence shall be built. It has been held, however, that the fence must be of sufficient height, strength and form of construction to keep off the animals referred to in the statute. It will be observed that the animals mentioned in the statute are any "cattle, or other domestic animals." There is no railroad commission or like commission or commissioner in Nevada having anything to do with cattle-guards.

NEW HAMPSHIRE.

Railroad Commissioners.—A board of three railroad commissioners is appointed by the governor, with the advice of the council, and has general supervision of all railroads within the state. It must keep

informed as to the condition of railroads and the manner in which they are operated with reference to the requirements of the laws and the security and accommodation of the public. It must make recommendations to the railroads of such changes in its operating or the conduct of its business as it thinks are necessary.

FENCES.—"The proprietors of every railroad shall erect and maintain a sufficient fence upon each side of their road except at the crossings of public highways."

If the railroad neglects to erect or maintain fences, the owner of adjoining land, if the work is not done within twenty days after notice to any agent of the railroad, may build or repair the fence himself and recover from the railroad twice the expense. On the other hand, if anyone other than the railroad corporation has agreed to repair or maintain the fence and fails to do so, the railroad may do the work and recover the actual expense from the person who should have done it.—P. S. Chapter 159, par. 23-25.

"All fences four feet high and in good repair, consisting of rails, timber, boards or stone wall, and all brooks, rivers, ponds, creeks, ditches, hedges, and other things deemed by the fence viewers to be equivalent thereto, shall be accounted legal and sufficient fences."—P. S. Chapter 143, par. 5.

CATTLE-GUARDS.—The proprietors of a railroad must construct and maintain upon each side of the highway at every crossing of a public highway "sufficient cattle-guards or fences to prevent cattle from passing upon their road."—P. S. Chapter 159, par. 23.

CATTLE-GUARDS.—The board of railroad commissioners, after a hearing, may determine the number, place, time and manner of construction of cattle-guards, passes or crossings, to be constructed by the railroad or the owner of land in cases where the parties can not agree themselves.

A fine of $25.00 is imposed for each month's neglect to carry out such an order of the railroad commissioners.—P. S. Chapter 159, par. 19-20.

NEW JERSEY.

That every corporation formed under this act shall erect and maintain fences on the sides of their road, of the height and strength of a division fence required by law, with openings or gates or bars therein, and farm crossing of the road for the use of proprietors of land adjoining such railroad; and also construct and maintain cattle-guards at all road crossings suitable and sufficient to prevent cattle and animals from getting on the railroad. Until such fences and cattle-guards shall be duly made the corporation and its agents shall be liable for all damages which shall be done by their agent or engines to cattle, horses or other animals thereon; and after such fences and guards shall be duly made and maintained, the corporation shall not be liable for any such damages, unless negligently or wilfully done; and if any person shall ride, lead or drive any horse or other animal upon such road, and within such fences and guards other than at farm crossings without the consent of the corporation, he shall, for every such offence, forfeit a sum not exceeding ten dollars, and shall also pay all damages which shall be sustained thereby to the party aggrieved; it shall not be lawful for any person, other than those connected with or employed upon the railroad, to walk along the track or tracks of any railroad, except where the same shall be laid along public roads or streets.

The statute also provides for fencing about railroad stations, and reads as follows:

"That it shall and may be lawful for any such company to cause a fence or other enclosure to be made around their depots, where the public

safety requires it, so as to prevent persons other than travelers from coming near the locomotives and train of cars, and to exclude from such enclosures all persons except travelers and the agents of the said companies."

What is deemed a lawful fence consists of posts and rails, timbers, boards, brick or stone walls, and all other fences if four feet two inches high, measured from the level or surface of the earth, strung sufficiently close to prevent horses and neat cattle from going through or under the same. A *fence constructed of* BARB WIRE, or wire on which is strung barbs or points, is not what *is deemed a lawful fence* unless the erection thereof shall be consented to by adjoining owners.

In New Jersey all railroad companies are not formed under the General Railroad Law. Therefore railroads not formed under that Act, and whose charter contains no provision requiring it to erect and maintain fences, are not required to do so, except as other owners are required to do, viz., each one-half. All railroads formed under the General Railroad Law must erect fences and cattle-guards as required by the statutes above mentioned.

NEW MEXICO.

Section 241.—Hereafter every railroad corporation whose lines of road, or any part thereof, are open for use, shall, within six months after the passage of this act, and every railroad company formed or to be formed, but whose lines are not now open for use, shall, within six months after the lines of such railroads, or any part thereof, are open, erect and thereafter maintain fences on the sides of their said railroad, or the part thereof so open for use, suitably and amply sufficient to prevent cattle, horses, sheep, mules, burros, and hogs from getting on the said railroad, except at the crossings of public roads and highways, and within the limits of towns, cities and villages, and shall also construct, where the same has not already been done, and hereafter maintain at all public road crossings, now existing or hereafter established, cattle-guards, suitable and sufficient to prevent cattle, horses, sheep, burros, mules, and hogs from getting onto said railroad. Until such fences and cattle-guards shall be constructed as herein directed, each and every one of such railroad corporations failing to comply with the directions of this act shall be liable in double damages in the manner and to the extent hereinafter limited and provided.

Section 242.—Whenever any cattle, horses, sheep, mules, burros, or hogs shall be killed, injured or destroyed by any railroad company operating a railroad in this territory or by its agents, trains, cars or locomotives, at any point on its line of road, where by law such railroad is required to be fenced, and the owner of any such animal, so killed, injured or destroyed, shall make affidavit of his ownership and of the injury or destruction of said property, and of the value of the same or of the amount of injury done thereto, and file the same with and give ninety days' notice in writing to any station agent, employed in the management of the business of such railroad company, in the county where the killing, injury or destruction complained of shall have been committed, such killing, injury or destruction is hereby made prima facie evidence of the negligence on the part of such railroad company; and if such railroad company, at the expiration of said ninety days, shall not have paid for the animal killed the fair market value thereof, or if the animal has not been killed, the actual amount of damage done by reason of the injury inflicted by such railroad company, upon suit brought for the recovery of damages for such killing, injury or destruction, judgment shall be rendered against said railroad company for the actual value of the animal or for the damage inflicted, if the animal has not been killed, unless said

company shall be able to overcome the presumption of negligence based upon the fact of the killing, injury or destruction, as herein provided, and establish that such killing, injury or destruction was not the result of negligence on the part of said railroad company or its agents in the management of its trains, cars or locomotives: Provided, that if the owner make claim for a greater sum than the actual market value of the property killed or destroyed, or for greater damage than was sustained by him on account of any injury to any such animal or animals, then, and in such event, in case judgment shall be rendered against the railroad company for a sum not exceeding or for a less sum than the amount offered and for which voucher was tendered by such railroad company in settlement and satisfaction of such claim, the costs of the action shall be taxed against such owner; And provided, further, the provisions of this act shall apply to railroad corporations in the hands of receivers, and in order to sue such receivers it shall not be necessary to obtain permission of the court by whom such receivers were appointed.

Section 243.—That for the purpose of this act a sufficient and suitable fence is defined and declared to be a fence at least four and one-half feet high, constructed of posts and wire, the top wire to be four and one-half feet above the ground, and shall have at least four wires upon posts not exceeding twenty feet apart.

The New Mexico statute of March 21, 1901, Chapter 86, page 165, reads as follows:—

Section 1.—That all of that part of Section 241, compiled laws of 1897, beginning with the word "until" in the fifth line from the bottom of said section to the end thereof, be and the same is hereby stricken out and the following inserted in place thereof: "If any railroad corporation shall fail to construct such fences and cattle-guards as herein directed, each and every one of said railroad corporations so failing to comply with the direction of this act shall be liable in damages in the manner and to the extent hereinafter limited and provided. And any railroad corporation which has so failed to fence its line, in addition to the penalties above described, shall be and hereby is required to post a notice in a conspicuous place upon its depot building at the county seat of the county through which its line or lines may run, every ninety (90) days, giving therein a full description of the brands and marks of every animal killed or damaged during the ninety days next preceding the posting of said notice.

Section 2.—This act shall take effect and be in force from and after its passage, and all acts and parts of acts in conflict therewith are hereby repealed.

NEW YORK.

Section 32. Fences, Farm-crossings and Cattle-guards.—Every railroad corporation, and any lessee or other person in possession of its road, shall, before the lines of its road are opened for use, and so soon as it has acquired the right-of-way for its roadway, erect and thereafter maintain fences on the sides of its road of height and strength sufficient to prevent cattle, horses, sheep and hogs from going upon its road from the adjacent lands, with farm crossings and openings with gates therein at such farm crossings whenever and wherever reasonably necessary for the use of the owners and occupants of the adjoining lands, and shall construct, where not already done, and hereafter maintain, cattle-guards at all road crossings, suitable and sufficient to prevent cattle, horses, sheep and hogs from going upon its railroad. So long as such fences are not made, or are not in good repair, the corporation, its lessee or other person in possession of its road shall be liable for all damages done

by their agents or engines or cars to any domestic animals thereon. When made and in good repair, they shall not be liable for any such damages, unless negligently or wilfully done. A sufficient post and wire fence of requisite height shall be deemed a lawful fence within the provisions of this section, but barbed wire shall not be used in its construction.

No railroad need be fenced, when not necessary to prevent horses, cattle, sheep and hogs from going upon its track from the adjoining lands. Every adjoining land owner, who, or whose grantor, has received compensation for fencing the line of land taken for a railroad, and has agreed to build and maintain a lawful fence along such line, shall build and maintain such fence. If such owner, his heir or assign shall not build such fence, or, if built, shall neglect to maintain the same during the period of thirty days after he has been notified so to do by the railroad corporation, such corporation shall thereafter build and maintain such fence, and may recover of the person neglecting to build and maintain it the expense thereof. And when such railroad shall cross timbered or forest lands, the company shall construct and maintain suitable and sufficient crossings, whenever and wherever reasonably necessary to enable the respective owners of said lands to transport lots, timber and lumber for manufacture or sale, or for banking on any stream, to be floated or driven down the same. In case of any neglect or dispute the Supreme Court may, by mandamus or other appropriate proceedings, compel the same, and also fix the point or location of any such crossing.

NORTH CAROLINA.

(Code 1883.) Section 1975. Railroad Companies to Construct and Maintain Cattle-guards, Etc.; Failure, Misdemeanor.—Every incorporated company, owning, operating or constructing, or which shall hereafter own, operate or construct, or any company which shall hereafter be incorporated, and shall own, operate or construct any railroad passing through and over the land of any person now enclosed, or which may hereafter become enclosed, shall, at its own expense, construct and constantly maintain in good and safe condition, good and sufficient cattle-guards at the points of entrance upon and exit from said enclosed land, and they shall also make and keep in constant repair crossings to any plantation road thereupon. Every such corporation which shall fail to erect and constantly maintain such cattle-guards and crossings shall be guilty of a misdemeanor, and fined in the discretion of the court, and shall be further liable to an action for damages to the party aggrieved.

NORTH DAKOTA.

When the owner of a tract of land abutting against a railroad shall desire to enclose such land for pasturage or other purpose, and shall construct a sufficient fence about said land on all sides except that abutting against such railway, the railroad company shall construct a good and sufficient fence, not less than four and one-half feet high, on the side of such land abutting on its line of railroad, and maintain the same in good repair and condition, until released from such duty by the owner of the tract of land.

When the owner has constructed his portion of the fence he shall give notice to the railroad, describing the land and number of acres to be enclosed, and the railroad shall thereupon construct its portion of the fence within sixty days after the service of the notice. If the railroad company fails to comply with the notice, the owner of the land may construct the right-of-way fence along the line of the railroad, and the rail-

road shall be liable to the land owner in any amount not exceeding $1.25 per rod of fence, and shall also be liable for all damages occasioned by its neglect to construct the fence.

OHIO.

Sections 3324, 3325, 3326, R. S., provide, in substance, that railroad companies are required to construct and maintain in good repair on each side of the road fences sufficient to turn stock; when such fence is constructed out of barbed wire, or separate lateral strands not connected by interwoven wire, or cross perpendicular wire not more than fifteen inches apart, there shall be securely fastened to the posts, at the top of the same, at right angles thereto, at least one board, not less than one and one-eighth inches thick and five inches wide, and extending the entire length thereof; and to construct and maintain cattle-guards at crossings of public roads, streets, lanes or highways sufficient to prevent domestic animals from crossing the same.

No specific kind of cattle-guard is mentioned in the statute, but it must be sufficient to prevent domestic animals from crossing.

Section 4239-a, R. S., prohibits the construction of a barbed wire partition fence, and attaches a penalty for the building of such partition fence, unless the same is built with the consent of the owner of the land.

OKLAHOMA.

Under the law of this territory it is made the duty of a railroad company to fence its right of way, except the public highways and station grounds, with a good and lawful fence. Said lawful fence is stated to be composed of posts and barb wires, four wires to be fastened firmly to the posts, said posts to be not more than one rod apart, the top wire to be not less than fifty-four nor more than fifty-eight inches from the ground, and the bottom wire to be not more than twenty nor less than fourteen inches from the ground. Any person owning or occupying land adjacent to any railroad track of any railroad company shall have the right to attach to the fence constructed along the track or right of way of said railroad company any wires, boards, or other material, so as to make the fence of said railroad company sufficient to prevent any hogs or pigs from getting upon the track of said railroad company.

There is no law requiring construction of cattle-guards.

OREGON.

Sections 5139, 5140, and 5146 of Vol. 2, Bellinger & Cotton's Annotated Codes and Statutes of Oregon (Ed. 1902), read as follows:

Section 5139. Killing Stock, When Railroads Liable For.—Any person, persons, company, or corporation, or lessee, or agent thereof, owning or operating any railroad within the State of Oregon, shall be liable for the value of any horses, mules, colts, cows, bulls, calves, hogs or sheep killed and for reasonable damages for any injury to any such live stock upon or near any unfenced track of any railroad in this state, whenever such killing or injury is caused by any moving train or engine or cars upon such track.

Section 5140. What Is Lawful Fencing of Track.—No railroad track shall be deemed to be fenced within the meaning of this act unless such track is guarded by such fence against the entrance thereon of any such live stock on either side of said track, and not more than one hundred feet distant therefrom: Provided, that whatever is a lawful fence under the laws of this state in the county where such killing or injury shall occur, and no other, under the laws of this state shall be deemed and

held a lawful fence under this act; And provided, further, that complete natural defenses against the entrance of such stock upon said track, such as natural walls or deep ditches, shall be deemed and held to be a fence under this act, when the same, in connection with other and ordinary lawful fences, forms a continuous guard and defense against the entrance of such live stock upon the track.

Section 5146. Railroad Track Between Ashland and Portland Required to Be Fenced.—Every person, company, or corporation now owning or operating the trunk line railroad, or which shall hereafter operate said trunk line railroad, between Portland and Ashland, shall, within six months after the passage of this act, commence to erect and thereafter maintain lawful fences on both sides of such trunk line railroad to prevent cattle, horses, sheep, hogs and other stock from going on such trunk line railroad, except at the crossings of and upon public roads and highways, and within such portion of cities and incorporated towns and villages as are or may be hereafter laid out and platted in lots and blocks, and except at railroad station grounds, with gates or bars at the farm crossings of such trunk line railroad, which farm crossings shall be constructed by such corporation, when and where the same may become necessary for the use of the proprietors of the lands adjoining such railroads; and shall construct, where the same has not already been done, and thereafter maintain at all public road crossings now existing or hereafter established, cattle-guards, reasonably sufficient to prevent cattle, horses, sheep, pigs and other stock from going on such trunk line railroad; and when such fences or cattle-guards are not made as aforesaid, or when such fences or cattle-guards are not kept in good repair, such person, company, or corporation owning or operating any such railroad, shall be liable to the owner thereof for all damages which may be done by the agents, engines, or cars of such person, company or corporation to such cattle, horses, sheep, hogs, or other stock thereon, and reasonable attorney's fees in any court wherein suit or action is brought to recover such damages, or to which the same may be appealed; but where such fences and guards have been made and kept in good repair, the fences to be lawful in all respects, such person, company, or corporation shall not be liable for any such damage; Provided, however, that no such action shall be maintaned until after such owner shall have given at least thirty days' notice in writing to such railroad company; and provided, further, that when such company shall have offered in writing to pay such damages as it may think has been sustained before any action at law has been commenced, and no larger sum shall be recovered, then in such case, such owner shall not recover any costs or disbursements or any attorney's fees. It shall be deemed a full compliance with this act, so as to preclude liability, if such railway company, person, or corporation, shall construct fencing for fifty miles of such trunk line railroad between Portland and Ashland annually.

Section 4334. Fields and Inclosures, How Fenced.—All fields and inclosures shall be inclosed with a fence sufficiently close, composed of posts and rails, posts and palings, posts and poles, posts and planks, palisades, or rails alone, laid up in the manner commonly called a "woven" fence or turf, with a ditch on either side, or wall of rock or stone four and a half feet high. (L. 1878, p. 23, Sec. 1; H. C. Sec. 3445.)

Section 4335. Character of Fence Required.—All such fences, composed of posts and rails, posts and palings, posts and poles, posts and planks, or palisades, shall be at least four and a half feet high; those composed of turf shall be at least four feet high, with trenches on either side at least three feet wide at the top and three feet deep; and what is commonly called a "woven" fence shall be at least five feet high to the top of the rider; if not ridered, shall be five feet to the top rail, and the corners shall be locked with strong rails, poles or stakes.

Section 4336. View as to Sufficiency of Fence.—In all cases, the sufficiency of the worm shall be determined by the persons who may be summoned to view said fence. (L. 1870, p. 21, Sec. 3; H. C. 3447.)

Section 4337. Animals Breaking Sufficient Fence, Damages Therefor.—If any horse, cattle, or stock break into any inclosures, the fence being of the height and sufficiency aforesaid, or if any hog, shoat, or pig shall break into the same, the owner of such animal shall for the first trespass make reparation to the party injured for the true value of the damages he shall sustain; and for every trespass thereafter, double damages, to be recovered, with costs, before a justice of the peace or any court of record having cognizance of the same demanded by the party injured. For the third offense from any of the animals aforesaid breaking into such inclosure, the party injured may take up such animals, and keep the same, at the expense of the owner. All animals so taken and kept in accordance with the provisions of this section shall be held as surety for the expenses of keeping; Provided, that the owner may at any time pay charges and take such animal away. (L. 1870, p. 21, Sec. 4; H. C. 3448.)

Section 4338. View on Complaint, as to Lawfulness of Fence.—Upon the complaint of the party injured to any justice of the peace of the county, such justice shall issue his order without delay to three disinterested householders of the neighborhood, nowise related to the parties, reciting the complaint, and requiring them to view the fence where the trespass is complained of, and take a memorandum of the same, and the testimony in such cases shall be good evidence on the trial touching the lawfulness of the fence. (L. 1870, p. 21, Sec. 5; H. C. 3449.)

Section 4339. Person Injuring Animal, Liable in Double Damages.—If any person damaged for want of such sufficient fence shall hurt, lame, kill, or destroy, or cause the same to be done, by shooting or otherwise, any of the animals in this chapter mentioned, such person shall satisfy the owner in double damages, with costs. (L. 1870, p. 22, Sec. 6; H. C. 3450.)

Section 4341. Damages Not Recoverable Unless Fence Lawful.—No action shall be maintained for damages done by any horse, mare, gelding, mule, ass, jenny, foal, bull, stag, cow, ox, steer, heifer, or calf, upon the premises of another, unless the person seeking such damage shall allege and prove upon the trial thereof that said premises was, at the time of the commission of said damage, inclosed with a lawful fence. (L. 1872, p. 123, Sec. 1; H. C. 3452.)

Section 4342. What Constitutes Lawful Fence.—The following shall constitute a lawful fence: All fences, except where otherwise provided, shall not be less than four feet six inches high from the surface of the ground, and the same shall be constructed either:—

1. Rails or poles, laid up in the manner commonly known as worm fence, with stakes and riders, or, in lieu thereof, to have the corners locked with rails, posts, or poles;

2. Posts and rails, with space between the rails, and between the rails and the ground, not exceeding ten inches wide below, two feet six inches in height, and not to exceed twelve inches at any place, the rails to be attached to the posts by nails, spikes, pins, wire, or in any other manner, if strong and secure; the posts to be firmly set in the ground, not more than ten feet apart from each other, and be not less than four feet six inches high from the ground;

3. Posts and poles, posts and planks, constructed in the manner required by subdivision 2 of this section, as to the length and setting of posts; and if the same is constructed of posts and plank, the plank to be not less than six inches wide and one inch thick, and the same shall be fastened as required if posts and rails;

4. Posts and paling, or pickets, or palisades, constructed in the usual manner, with space not exceeding five inches;

5. Wall of stone entire, or stone with rails, poles, plank, or earth, which, taken together, would constitute a fence four feet six inches high;

6. Turf and earth entire, or turf and earth, which, with rails, poles, plank, or thorn bush, would constitute a fence four feet six inches high, with a ditch or trench on the side, at least three feet wide at the top, and not less than three feet deep; Provided, that when there is a ditch or trench on the side, as before provided for, and constructed in the manner hereinbefore specified, said fence shall be not less than four feet high from the surface of the ground;

7. Posts and rails, poles or plank, not less in size than hereinbefore specified, with posts set in the ground not more than ten feet apart, leaning upon braces sufficiently strong to support the same, with the poles, rails, or plank, as the case may be, not less than three in number to the panel, securely fastened to posts; Provided, that all fences heretofore constructed which fill the requirements of this section shall be deemed lawful fences; And provided further, that all precipices, embankments, streams, lakes, ponds, or other natural obstruction, if equally secure against the trespass of any domestic animals, or shall be made so by artificial means, shall be deemed lawful fences. (L. 1872, p. 123, Sec. 2; L. 1874, p. 65; H. C. 3453.)

Section 4345. Wire Fence East of Cascades, How Constructed.—All wire fences in any of the counties east of the Cascade Mountains in this state, except the county of Union, shall be constructed in the following manner: They shall have posts six and one-half feet in length, and not less than four inches in diameter, made of sound timber; such posts shall be set in the ground two feet, and shall be not further than thirty-two feet apart; there shall be not fewer than three wires of the kind in common use, stretched from post to post; the lower wire shall be two feet from the ground, the second fifteen inches above the lower, and the upper one fifteen inches from the second one. Said wires shall be fastened to the posts securely in the customary manner, and at the distance of eight feet from each of said posts, and at every space of eight feet from each other, throughout the entire length of such fences, there shall be poles or false posts set up on the ground, four and a half feet in height, to which the wires of such fences shall be securely fastened; and on each side of such fences, if the ground can be plowed, three furrows, at least four inches deep. Said furrows must be plowed within two feet of the fences; Provided, that in cases where the land cannot be plowed, or in other cases, a pole not less than two inches thick at the small end, or plank not less than one inch thick by six inches wide, affixed to posts, as above provided, but not more than sixteen feet apart, may take the place of the middle of the wire and false posts and plowing. (L. 1885, p. 112, Sec. 1; H. C. Sec. 3456.)

Section 4346. Fences Must Be Kept in Repair.—It shall be the duty of all persons having wire fences to keep them in good repair. (L. 1885, p. 112, Sec. 2; H. C. Sec. 3457.)

Section 4347. What Fences Deemed Lawful Against Horses and Cattle.—All fences made and kept in repair as hereinbefore required, shall be deemed and held to be a lawful fence against horses and cattle. (L. 1885, p. 112, Sec. 3; L. 1887, p. 57, Sec. 1; L. 1889, p. 52, Sec. 1; H. C. 3458.)

Section 4348. Barbed Wire Fences West of Cascades, How Constructed.—All barbed wire fences in any of the counties west of the Cascade Mountains in this state shall have a board not less than one by six inches, or a pole not less than four inches in diameter, securely fastened to post and false post, not further than eight inches below the top barbed wire. (L. 1885 (special session), p. 40, Sec. 1; H. C. 3459.)

Section 4349. Barbed Wire Fences Must Be Kept in Good Repair.—It shall be the duty of all persons having barbed wire fences to keep them in good repair. (L. 1885 (special session), p. 41, Sec. 2; H. C. 3460.)

Section 4350. Injury to Stock from Barbed Wire Fence, Damages When Recoverable.—All cases in which stock shall be killed or injured by coming in contact with barbed wire fences, which are not at the time of injury kept in substantial compliance with the terms of this act, the owner of the stock so killed or injured shall have the right to recover from the owner of such fence, by action of the law, a sum equal to the amount of the injury sustained by him in the killing or injury to his stock as aforesaid. (L. 1885 (special session), p. 41, Sec. 3; H. C. 3461.)

Section 4351. Partition Fence, Adjacent Owner Must Contribute, When.—Whenever a fence, of whatever material constructed, and in all respects such as a good husbandman ought to keep, is or shall hereafter be erected on the line of his land, or that on which he may have a lease for one or more years, and the person owning the land adjoining thereto, or holding a lease on the same for one or more years, shall make or cause to be made or have an inclosure on the opposite side of such fence, so that such fence may answer the purpose of inclosing his field, meadow, lot, or any other inclosure, such person shall pay the owner of such fence already erected one-half of the value of so much thereof as serves as a partition fence, such value to be determined by the parties; or, in case they cannot agree, then the party aggrieved and entitled to compensation for constructing or repairing such fence shall be entitled to recover from the other in a civil action the value of one-half of such fence, or half of the value of repairing the same, before any court having competent jurisdiction, in the name of and for the use of the owner or lessee of such fence, together with his disbursements and costs of action. (L. 1862, D. Cd., p. 832, Sec. 1; L. 1880, p. 46, Sec. 1; H. C. 3462.)

Section 4352. Complaint for Not Keeping Up Partition Fence.—If any party neglect to repair or rebuild such partition fence, or the portion thereof which he ought to maintain, the aggrieved party may complain to a justice of the peace, who, after due notice to each party, shall examine the same, and if he determine the fence to be insufficient, he shall signify in writing to the delinquent occupant of the land, and direct him to repair or rebuild the same within such time as he shall judge to be reasonable.

Section 4353. Complainant May Repair and Recover From Delinquent.—If such fence be not repaired or rebuilt accordingly, the complainant may repair or rebuild it, and recover the value thereof from such delinquent before any court having competent jurisdiction. (L. 1862, D. Cd., p. 833, Sec. 3; H. C. 3464.)

Section 4354. One Owner Cannot Remove Part of Partition Fence.—When one party shall cease to improve his land, or shall open his inclosure, he shall not take away any part of the partition fence belonging to him and adjoining the next inclosure, if the owner or occupant of such adjoining inclosure will, within two months after the same shall be ascertained, pay therefor such sum as shall be agreed upon by the parties, or, if failing to agree, then such sum as may be adjudged by two or more disinterested persons, as provided in section 4351. Nor shall such partition fence be removed when by so doing it will expose to destruction any crops in such inclosures. (L. 1862, D. Cd., p. 833, Sec. 4; H. C. 3465.)

Section 4355. Removal of Fence Built on Another's Land by Mistake.—When any person has built, or shall hereafter build, by mistake and in good faith, a fence on the land of another, such person or his successor in interest may, within one year from the time of discovering such mistake, go upon the land of such other person and remove such fence, doing no unnecessary damage thereby. (L. 1862, D. Cd., p. 833, sec. 5; H. C. 3466.)

Section 4356. Owner of Land Not to Disturb Fence Within What Time.—The occupant or owner of land whereon a fence has been built by mistake shall not throw down or in any manner disturb such fence during the period which the person who built it is authorized by the last section to remove it. (L. 1862, D. Cd., p. 833, Sec. 6; H. C. 3467.)

Section 4357. County Surveyor May Be Required to Run Line.—The person building such fence, or the occupant or owner of the land whereon the same is built, may, upon notice to the other party, whenever doubts arise about the location of such fence, require the surveyor of the county to run the division line between their respective lands, and the line so run shall be sufficient notice to the party making the mistake so as to require him to remove such fence within one year. (L. 1862, D. Cd., p. 833, Sec. 7; H. C. 3468.)

Section 4358. When Share of Partition Fence May Be Removed.—In all cases where the inclosures of two or more persons shall be divided by a partition fence of any kind, and either of the parties shall think proper to vacate his part of such inclosure, or to make a lane or passage between such adjoining inclosures, such person shall be at liberty to remove his share or part of such partition fence, on giving six months' notice in writing of such intention to the party owning or occupying the adjoining inclosure, or to his agent, if such party is not a resident of the county. (L. 1862, D. Cd., p. 834, Sec. 8; H. C. 3469.)

Section 4359. Gate in Partition Fence, Who May Use.—In all cases where a partition fence exists between parties, and a gate is established for passage through their lands, any other person may pass through such gate free, doing no unnecessary damage, and if any such person shall leave any such gate open, or do other damage to the premises, he shall be liable to party aggrieved in double damages. (L. 1862, D. Cd., p. 834, Sec. 9; H. C. 3470.)

PENNSYLVANIA.

There is no general statute in Pennsylvania requiring a railroad company to fence its right-of-way or to put up cattle-guards. There are, however, some special statutes on the subject relating to particular counties in the state.

"An Act to secure farmers against losses caused by railroads in Erie County."—Act of March 23, 1868, P. L., 424.

This requires each company owning or operating a railroad in the County of Erie to erect, keep and maintain on each side of the track or tracks of its railroad, at all places in said county, except where said road or roads pass through a village, borough or city, or a public road crosses the same, a suitable fence five feet high.

"An Act for the protection of farmers and owners of cattle, horses, sheep and swine along the line of railroads in the County of Warren."—Act of March 28, 1868, P. L., 514.

This requires all railroad companies to construct and keep in repair, or cause to be constructed and kept in repair, a good and sufficient fence at least four feet high along their track, except through incorporated boroughs, and to construct sufficient cattle-guards at all railroad crossings.

"An Act to secure farmers and others against losses of horses, cattle, sheep and swine, by railroads in the County of Centre."—Act of April 9, 1868, P. L., 779.

This act requires each company operating a railroad in the county to erect, keep and maintain on each side of its track or tracks, at all places in said county, except where said road or roads passes or pass through a village, borough or city, or a public road crosses the same, a

suitable fence, five feet high, and to build, erect and maintain such suitable cattle-guard or guards at all crossings on said railroad as will prevent cattle, horses, sheep and swine from going upon said tracks.

"Act approved April 13, 1868, P. L., 1022."

This Act amends the Act relating to Erie County, providing that that Act shall not apply to lands in said county in regard to which contracts exist by virtue of which the owners thereof are bound to build and maintain fences thereon along the line of the railroad passing through or along the same.

"Act approved April 17, 1869, P. L., 1125."

This Act extends the provision of the Act relating to Warren County to the counties of Bradford, McKean and Venango.

While it is true that there is no statutory provision requiring the railroad companies to fence their right-of-way, it has been held, in several cases, that a railroad company failing to erect cattle-guards or put up fences at points where cattle are in the habit of straying may, as against passengers, be held guilty of negligence for such neglect.

RHODE ISLAND.

Lawful fences are as follows: A three-foot hedge, with ditch; a four-foot hedge; a post and rail fence four and one-half feet, with ditch; a stone wall four feet, with overhanging flat stone, or four and one-half feet without such stone; all other kinds of fences not above described, four and one-half feet high.

There are no statutes in Rhode Island with reference to fences and cattle-guards, except that a railroad shall be obliged to fence its track within the limits of the city of Providence in such manner and at such places as directed by the board of aldermen, and subject to a penalty of $50 for neglect.

SOUTH CAROLINA.

(Code, 1902.) Section 2185.—The several railroad companies whose line of road lies wholly or partly in this state are hereby required to construct and keep in repair an adequate stock-guard or cattle-gap at every point where the line of said railroad or of any such company crosses or may hereafter cross the line of any fence in this state.

Section 2186.—For every violation of Section 2185 the railroad company so violating it shall pay to the owner or owners of the fence upon the line of which such stock-guard or cattle-gap should have been constructed and kept in repair the sum of one hundred dollars, to be recovered by action in the Court of Common Pleas for the county in which such stock-guard or cattle-gap should have been constructed and kept in repair.

SOUTH DAKOTA.

Chapter 128 of the laws of South Dakota (1901) is as follows: Whenever the owner of any tract of land abutting against any line of railroad within this state shall desire to enclose any such tract of land for pasturage, and shall construct a good and sufficient fence about said tract of land on all sides except along the side abutting against such railroad, it shall be the duty of such railroad company to construct a fence not less than four and one-half feet high, and when such tract of land is intended for pasturage, such fence shall be good and sufficient for the pasturage for which such tract of land is desired to be enclosed,

on the side of such tract or lot so far as the same extends along the line of such railroad, and to maintain the same in good repair and condition until released therefrom by the owner of said tract, or until the owner of said tract shall have ceased to maintain in good repair and condition for the term of one year his portion of the fence around such enclosure.

There are no provisions in the statutes of South Dakota relating to cattle-guards.

TENNESSEE.

RAILROADS MUST FENCE TRACK OR BE LIABLE FOR STOCK INJURED.—There is no law in Tennessee affirmatively requiring railroads to fence their tracks. By Acts of 1891, Chap. 101, however, they are rendered absolutely liable for all stock killed or injured unless their tracks are inclosed with good and lawful fences and good and sufficient cattle-guards. The same acts gives them absolute exoneration from liability where legal fences and cattle-guards are erected.—See Acts Tenn. 1891, Chap. 101; Code Tenn. (Shannon's), Sec. 1597, et seq.

WHAT ARE LAWFUL FENCES.—The following are in Tennessee:

(1) Stone. A substantial stone fence or wall, three and one-half feet high.—Acts Tenn., 1877, Chap. 35, Sec. 2; Code Tenn. (Shannon's) Sec. 2980.

(2) Plank and post and rail. A post and plank, or post and rail fence four feet high. Id.

(3) Rail. A common worm or crooked rail fence five feet high. Id.

(4) Bank. Every bank or other means used as a fence, or part of a fence, equivalent as an obstruction to stock, to either of the three classes of fence above named. Id.

(5) Wire. Any inclosure made by nailing fast two sound planks, each not less than six inches wide, to posts set firmly in the ground not more than eight feet apart, the bottom plank to be not more than three inches from the ground, and the second plank from the ground not more than four inches from the first; and then by stretching not less than four strands of barbed wire tightly between said posts above the planks, the topmost wire to be not less than four and one-half feet from the ground, and the bottom wire to be four inches from the topmost plank; the next wire from the bottom one to be nine inches from the topmost plank and the third wire from the bottom to be twenty-one inches from the topmost plank, the above distance as nearly as practicable.—Acts Tenn., 1883, Chap. 46, Sec. 2.

(6) Osage Orange. Bois d'arc or osage orange fences, wholly of bois d'arc or osage orange, or in part of bois d'arc or osage orange, and in part of wire or other material, at least four feet high, and at least eighteen inches across the top and sufficiently close to prevent stock of all kinds from passing through. Id.—Shannon's Code, Tenn., Sec. 2980.

(7) Wire; for horses, cattle, and mules. The following shall be sufficient and be deemed a lawful fence only as to cattle, horses, and mules: Any inclosure made by stretching not less than five strands of barbed wire tightly between posts firmly set in the ground, or between growing trees and posts firmly set in the ground, not more than twenty feet apart; the topmost wire not less than four and one-half feet from the ground, the bottom wire not less than six inches, and the next to the bottom wire not less than fifteen inches from the ground.—Code Tenn. (Shannon's), Sec. 2981.

(8) Three-wire, plank, or slat fence. In addition to the fences in Sec. 2980, defined to be lawful fences (which are also hereby declared to be lawful fences), the following shall also be a lawful fence, to-wit: A fence built of good sized, substantial posts, set firmly in the ground, not more than nine feet apart. Said fence shall consist of three barbed wires, or three planks, or three slats running horizontally and fastened firmly to said posts, the first to be eighteen inches from the ground, and the second and third eighteen inches from the first and second, respectively, counting from the center of each. Said fence may consist entirely of wire strands, or of planks, or of slats, or it may be composed of a wire, plank and slat.—Acts Tenn., 1891, Chap. 92; Code Tenn. (Shannon's), Sec. 2982.

TEXAS.

Article 4427.—All railway corporations in this state which have, or which may hereafter fence their right-of-way, may be required to make openings or crossings through their fence and over their roadbed along their right-of-way every one and one-half miles thereof; provided, that if such fence shall divide any inclosure, that at least one opening shall be made in said fence within such inclosure.

Article 4428.—Such crossings shall not be less than thirty feet in width, and shall be made and kept in such condition as to admit of the free and easy passage of horses, cattle, sheep, hogs, and all other domesticated animals, wagons and other vehicles.

Article 4429.—Such crossings shall be made at such times and places as may be demanded by any two or more citizens of the state who either live or own land within five miles of the place where such crossings may be demanded.

Article 4430.—Such demand shall be made in writing, of the nearest local agent of such railway company, to the place where such crossing or crossings are demanded, and shall state when and where such crossing is desired.

Article 4431.—No railway company shall be required to complete such crossing as may be demanded under this chapter in a shorter time than thirty days from the day on which such demand is first made, nor shall they be required to make any crossings where they have already left such crossings in each one and one-half miles of their road, except inside of inclosures, as provided in article 4427.

Article 4432.—Any railway company, upon such demand, shall be deemed to have complied therewith upon making such crossings within four hundred yards of the place where they are demanded, within the time herein allowed.

Article 4433.—Whenever any railway company shall fail or refuse to comply with the requirements of this chapter, after demand is made in accordance herewith, such railway company shall pay to the persons who made such demand each the sum of five hundred dollars for each and every month they shall so fail or refuse to comply with such demand, the same to be recovered by suit in any court of this state having jurisdiction of the amount.

Article 4434.—Nothing in this chapter shall be so construed as to affect the law requiring railroad companies to provide proper crossings at intersection of all roads and streets.

Article 4435.—It shall be the duty of every railroad company in this state to place and keep that portion of its roadbed and right-of-way, over or across which any public county road may run, in proper condition for the use of the traveling public, and in case of its failure to do so for

thirty days after written notice given to the section boss of the section where such work or repairs are needed by the overseer of such public road, it shall be liable to a penalty of ten dollars for each and every week such railroad company may fail or neglect to comply with the requirements of this article, recoverable in any court having jurisdiction of the amount involved, in a suit in the name of the county in which the cause of action accrued.

Article 4436. 4171.—In no case shall any railroad company construct a roadbed without first constructing the necessary culverts or sluices, as the natural lay of the land requires, for the necessary drainage thereof.

Article 4523. 4240.—Each and every railroad company whose railway passes through a field or inclosure, is hereby required to place a good and sufficient cattle-guard or stop at the points of entering such field or inclosure, and keep them in good repair.

Article 4524. 4241.—In case an inclosure or field through which a railway passes shall be enlarged or extended, or the owner of the land over which a railway runs shall clear and open a field so as to embrace the track of a railway, such railroad company is hereby required to place good and sufficient cattle-guards or stops at the margins of such extended inclosures or fields, or such new fields, and keep the same in repair.

Article 4525. 4242.—Such cattle-guards or stops shall in all cases be so constructed and kept in repair as to protect such fields and inclosures from the depredations of stock of every description.

Article 4526. 4243.—Should any such company fail to construct and keep in repair such cattle-guards and stops, the owner of such inclosure or field may have such cattle-guards and stops placed at the proper places and kept in repair, and may recover the costs thereof from such railroad company, unless it be shown that the enlargement or extension, as above provided, was made capriciously and with intent to annoy and molest such company.

Article 4527. 4244.—Should any such company neglect to construct the proper cattle-guards and stops and keep the same in repair, as required by law, such company shall be liable to the party injured by such neglect for all damages that may result from such neglect, to be recovered by suit in any court having jurisdiction.

Article 4528. 4245.—Each and every railroad company shall be liable to the owner for the value of all stock killed or injured by the locomotives and cars of such railroad company in running over their respective railways, which may be recovered by suit before any court having competent jurisdiction of the amount. If the railroad company fence in their road, they shall only then be liable in cases of injury resulting from want of ordinary care.

Article 2496. 2431.—Every gardener, farmer or planter shall make a sufficient fence about his cleared land in cultivation, at least five feet high, and make such fence sufficiently close to prevent hogs from passing through the same, but it shall be unlawful for any persons whomsoever, by joining fences or otherwise, to build or maintain more than three miles, lineal measure, of fence running in the same general direction without a gateway in the same, which gateway must be at least eight feet wide, and shall not be locked.

UTAH.

Section 1. Railroad Companies to Fence Tracks.—Penalty.—Every railroad company operating a railroad by steam power within this state is hereby required to erect, within six months after the approval of this act, and thereafter maintain a fence on each side of its railroad where

the same passes through lands owned and improved by private owners, and connect the same at all public road crossings with cattle-guards. Such fence shall not be less than four and a half feet in height, and may be constructed of barbed or other fencing wire, and shall consist of not less than five wires, with good, substantial posts, not more than one rod apart, with a stay midway betwen said posts attached to the wires of said fence to keep said wires in place; and whenever such railroad company shall provide gates for private crossings, for the convenience of the owners of the lands through which such railroad passes; such gates shall be so constructed that they may be easily operated; and any such corporation shall be liable for all damages sustained by the owner of any domestic animal killed or injured by such railroad, in consequence of the failure to build or maintain such fence, when such animal strays upon such railroad, where it passes through the property of the owner thereof.

Section 2. Must Provide Gates for Private Crossings.—Wherever such railroad company shall provide gates for private crossings for the convenience of the owner of the lands through which such railroad passes, such owner shall keep such gates closed at all times when not in actual use, and if such owner fail to keep such gates closed, and in consequence thereof his animal strays upon said railroad, and is killed or injured, such owner shall not be entitled to recover damages therefor.

It is also provided by subdivision 34 of Section 206 of the Revised Statutes of Utah, of 1898, as amended by the Utah statute of March 23, 1901, chapter 124, page 133, entitled "Powers of City Councils," that the City Council shall have power to require railroad companies to fence their respective railroads or any portion of the same, and to construct cattle-guards, crossings of streets and public roads, and keep the same in repair within the limits of the corporation.

VERMONT.

Railroad Commissioners.—Three railroad commissioners are appointed by the Governor with the consent of the Senate, with general supervision over all steam railroads; they must keep themselves informed as to how the railroads accommodate the public and comply with the laws. They may make recommendations, among other matters, as to changes in operating which they think best, and the railroads must obey if the orders are just and reasonable. The Supreme Court has jurisdiction in equity to enforce recommendations if on hearing they seem just and reasonable.—Vermont Statutes, par. 3989-3995.

Fences.—A railroad corporation must construct and maintain on the sides of its road a good and sufficient fence, and if this is not done, a person aggrieved may construct it, and the railroad must pay the cost after appraisal by the selectmen. Until fences or cattle-guards are made, railroads are liable for all damages to animals caused by want of them. But if the railroad corporation has paid the land owner to construct and maintain the fence, and the latter fails so to do, the railroad can build it and recover the expense of such owner or his grantee.

Railroad commissioners have jurisdiction, upon complaint in writing by owner of land through which railroad passes that he is aggrieved by the neglect or default of a railroad company in constructing or maintaining fences, cattle-guards or farm crossings which the company is bound to construct or maintain, and after a hearing may make such orders as are proper, which the railroad company must perform under penalty of fine. Railroad company cannot be required to build fences while ground is frozen.—Vermont Statutes, par. 3874-3882.

Fences four and a half feet high and in good repair, and lakes, ponds,

rivers, brooks, creeks, hedges, ditches, or other things equivalent to such fence shall be deemed sufficient.—Vermont Statutes, par. 3567.

There is no duty on land owners to fence against highways, but this will not relieve railroads from maintaining cattle-guards at highway grade crossings.—Vermont Statutes, par. 3873.

VIRGINIA.

Supplement to Code, 1898. Paragraph 1258 (as amended by Act approved February 15, 1900). To Enclose Roadbeds with Fences; Cattle-guards.—Every such company shall cause to be erected along its line and on both sides of its roadbed lawful fences, as defined in Section 2038, which may be made of timber or wire, or of both, and shall keep the same in proper repair, and with which the owners of adjoining lands may connect their fences, at such places as they may deem proper. In erecting these fences, the company shall, at the termini of those portions of its roadbed which it is required to fence, and on each side of all public and private crossings, construct across its roadbed and keep in good repair sufficient cattle-guards, with which its fences shall be connected. Such cattle-guards at private crossings may, with the consent of the owners of said crossings, be dispensed with, the company, in lieu of cattle-guards, erecting and keeping in good order sufficient gates. But no court of this commonwealth shall have jurisdiction, by writ of mandamus or otherwise, to compel the erection of such fences or building of such cattle-guards; provided, that through lands or lots, actually enclosed with a fence where the railroad company has already or may hereafter fence its right-of-way, mandamus may lie to require such company to maintain its fencing; and provided, however, that such company may at any private crossing or private wagon-way erect gates or bars in addition to the cattle-guards required by this act, if, in the judgment of said company, the hazard to trains at such crossing requires gates or bars as an additional safeguard to life and property on the trains.

Section. Qualification of Preceding Section.—The preceding section, so far as it relates to fencing, shall not apply to any part of a railroad located within the corporate limits of a city or town or between the terminals of the switches either way from the company's depots nor to any part of a railroad at a place where there is a cut or embankment with sides sufficiently steep to prevent the passage of stock at such place, nor shall it apply to a company which has compensated the owner for making and keeping in repair the necessary fencing, but the burden of proving such compensation shall be on the company; and no report of any commissioners shall be received as proof thereon unless it shall plainly appear on the face of the report or from other evidence in connection thereof that an estimate was made by such commissioner for the fencing, and the expense for the same entered into and constituted a part of the damages reported and actually paid.

WEST VIRGINIA.

The only provision of the law of West Virginia that requires railroads to construct cattle-guards or fences is that with reference to property acquired by a railroad company through condemnation proceedings. The law provides that in all cases where property is taken under condemnation proceedings by a railroad company, and is land which has been cleared and fenced, the railroad company shall construct and forever maintain suitable farm crossings, cattle-guards and fences on both sides of the land thus taken.

There is no specific provision with respect to cattle-guards. In cases in which fences are by law required to be built, the statute provides that, if built of common rails, the fence shall be four and one-half (4½) feet high; if built of posts and rails or posts and plank or pickets, four (4) feet high; if built of stone two (2) feet wide at base, three and one-half (3½) feet high; if hedge fence, four (4) feet high; if built of posts and wire or pickets and wire, four (4) feet high, with not less than six strands, the first of which must be five (5) inches from the ground, the second ten (10) inches, the third seventeen (17) inches, the fourth twenty-five (25) inches, the fifth thirty-six (36) inches, and the sixth forty-eight (48) inches from the ground.

WISCONSIN.

Section 1810, Vol. I., Rev. Stat., Wis. (1898), provides that every railroad corporation operating any railroad shall erect and maintain on both sides of any portion of its road (depot grounds excepted) good and sufficient fences of the height of four and a half feet, with openings or gates, or bars therein, and suitable and convenient farm crossings of the road for the use of the occupants of the lands adjoining, and shall construct and maintain cattle-guards at all highway crossings, and connect their fences therewith to prevent cattle and other domestic animals from going on such railroad. All roads hereafter built shall be so fenced, and such cattle-guards be made within three months from the time of commencing to operate the same, so far as operated.

A barbed wire fence, consisting of not less than five barbed wires, with at least forty barbs to the rod, firmly fastened to posts, well set, not more than sixteen and one-half feet apart, with one good stay between, the top wire not less than forty-eight inches high and the bottom wire not more than eight inches from the ground, and the spaces between the bottom and second and second and third wires from the ground not more than eight inches each, shall be deemed a good and sufficient fence; and no fence shall be required in places where the proximity of ponds, lakes, water-courses, ditches, hills, embankments, or other sufficient protection renders a fence unnecessary to protect cattle or other domestic animals from straying upon the right-of-way or track; provided, that nothing herein shall affect or render unlawful any fence built by any railroad company prior to the thirtieth day of March, 1881.

Provisions of the law in Wisconsin as to cattle-guards is contained in the section relating to fences noted above and reads, "shall construct and maintain cattle-guards at all highway crossings and connect their fences therewith to prevent cattle and other domestic animals from going on such railroad."

WASHINGTON.

In an action for injuries to stock, except hogs, by trains, a failure to fence is prima facie evidence of negligence. When a railroad company fences its track through occupied or cultivated land, it shall, at its expense, put in and maintain crossings with gates and bars to give the owner access to the several parts of his land, provided that not more than one crossing in every half mile shall be required upon the property of any one owner. Failure to provide such crossings with gates and bars within sixty days after written notice from the owner subjects the railroad to a penalty of not more than $250.00, to be recovered by the owner of the land.

CANADA.

Chapter 29, Section 194.—When a municipal corporation for any township has been organized and the whole or any portion of such town-

ship has been surveyed and subdivided into lots for settlement, fences shall be erected and maintained on each side of the railway through such township, of the height and strength of an ordinary division fence, with openings or gates or bars or sliding or hurdle gates of sufficient width for the purposes thereof, with proper fastenings at farm crossings of the railway, and also cattle-guards at all highway crossings, suitable and sufficient to prevent cattle and other animals from getting on the railway: Provided always, that in New Brunswick, Nova Scotia and Prince Edward Island, wherever a county municipality has not been subdivided into local municipalities, each improved or occupied lot of land shall be protected by fences, gates and cattle-guards, as in this section provided:

2. A hurdle gate has proper fastenings if it is fifteen inches longer than the opening, and is supported at each end by two upright posts.

3. Until such fences and cattle-guards are duly made and completed, and if after they are so made and completed they are not duly maintained, the company shall be liable for all damages done by its trains and engines to cattle, horses and other animals, not wrongfully on the railway, and having got there in consequence of the omission to make, complete and maintain such fences and cattle-guards as aforesaid.

Section 195.—If the land through or by which the railway passes is occupied at the time of the construction of the railway opposite thereto, the company shall make such fences, gates and cattle-guards as they lay their rails.

Section 196.—After such fences, gates and guards have been duly made and completed, and while they are duly maintained, no such liability shall accrue for any such damages, unless the same are caused willfully or negligently by the company or by its employés.

Section 197.—At every public road crossing at rail level of the railway, the crossing shall be sufficiently fenced on both sides so as to allow the safe passage of the trains.

Section 198.—The persons for whose use farm crossings are furnished shall keep the gates at each side of the railway closed when not in use; and no person, any of whose cattle are killed by any train owing to the non-observance of this section, shall have any right of action against any company in respect to the same being so killed.

Section 199.—Every person who willfully leaves any such gate open without some person being at or near it to prevent animals from passing through it on to the railway, or who takes down any part of a railway fence, or turns any horse, cattle or other animal upon or within the enclosure of such railway, is liable, on summary conviction, to a penalty of twenty dollars for each offense, and is also liable to the railway company for any damage to the property of the company or for which the company is responsible, by reason of such gate being so left open, or by reason of such fence being so taken down, or by the turning upon or within the enclosure of such railway of any horse, cattle or other animal; and no person, any of whose cattle are killed by any train owing to the non-observance of this section, shall have any right of action against any company in respect to the same being so killed.

DISCUSSION.

MR. J. B. BERRY (Union Pacific Railroad—by letter) :—I do not believe that the Association can recommend a standard fence. The fence laws of the different states do not agree, and I believe that this matter should be left to each company to settle for itself.

The question of cattle-guards still remains. I am about as much in the dark in regard to them as I was fifteen years ago. The only guard I know of that seems to be effective is the one known as the "pit" guard, but this is somewhat expensive and is in many cases unsatisfactory. I would like to see, however, the criticisms brought out by the various members on the different types of cattle-guards, and if the Committee think it advisable, I will state some of the difficulties we have encountered with the various kinds.

MR. J. V. HANNA (St. Louis & San Francisco Railroad—by letter) :—The writer thinks the Committee should specify a standard spacing for wires, posts, etc. It is clearly understood that the specifications of the various committees are intended to represent the best practice under usual conditions. Such a specification for fencing seems just as desirable as for other matters where variation must be made to meet local conditions. No doubt many engineers, not being tied down to any particular form, spacing, etc., would be glad to know that there was a form and spacing found to give good service, sufficiently good to receive the endorsement of this Association.

The writer thinks the recommendations of the Committee good, but, before saying the conclusions are sufficiently supported by their arguments to justify adoption, would like to see arguments against them clearly set forth.

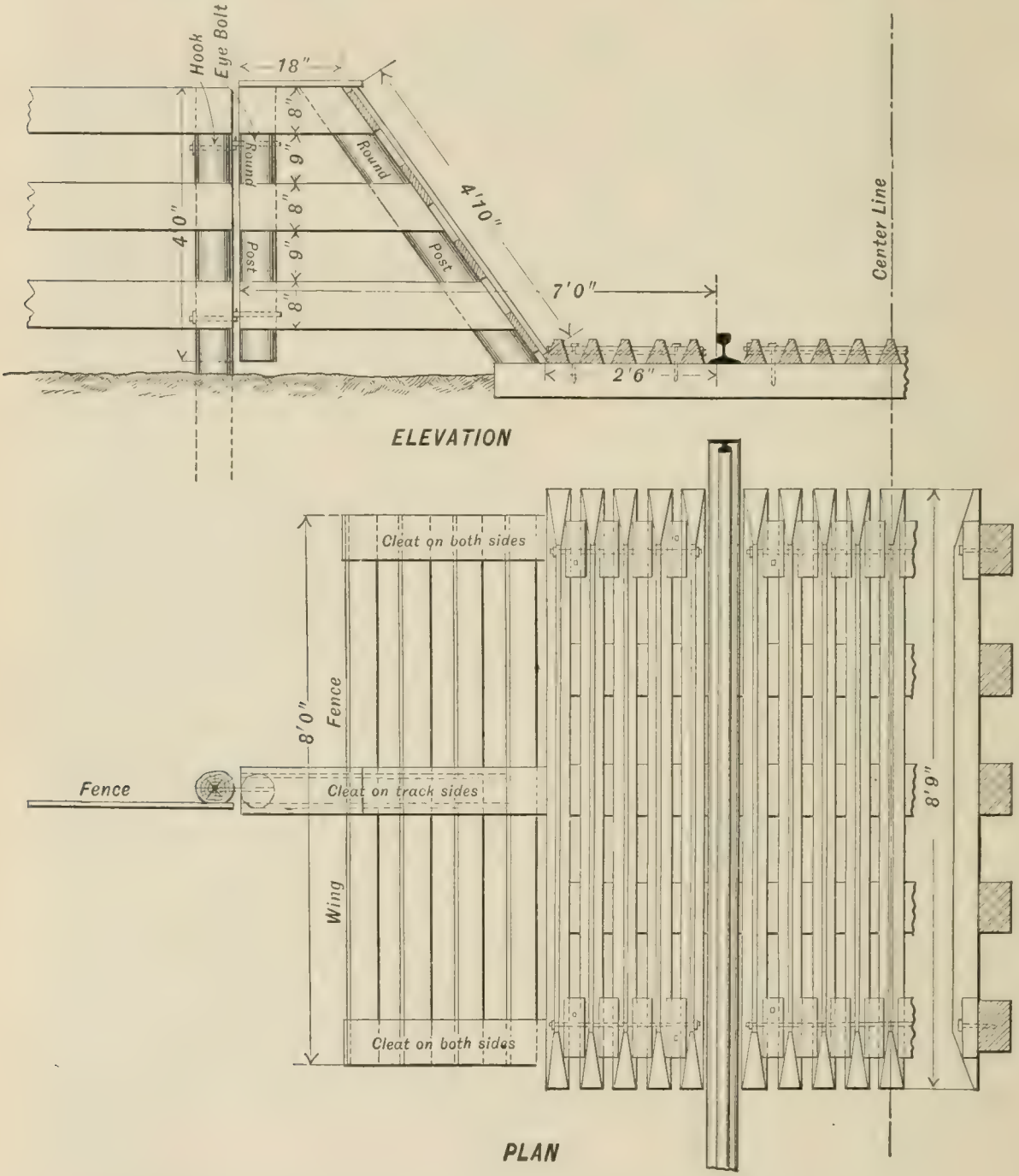
MR. W. C. CUSHING (Pennsylvania Lines—by letter) :—It seems to me that the report of this Committee has been admirably well handled and I have few suggestions to make in regard to it.

The principal omission which I notice is in the specifications concerning the spacing of posts. That is one of the very important questions and I would like to see the Committee make a recommendation.

They omit also to say anything about the kind of wire used, that is, whether it is galvanized or plain, and I would like to state for the benefit of the Committee that the Pennsylvania Lines have been obtaining very bad service indeed from the galvanized wire purchased within the past few years. A suggestion has been made that we experiment with plain wire boiled in oil, and it is quite likely that we will give some study to the matter.

MR. J. P. SNOW (Boston & Maine—by letter) :—I beg to submit a design for apron and wing fences at cattle-guards which is somewhat different from those shown by the Committee.

The apron is readily detachable from the wing fence, the object of this feature being to allow the apron to be removed during the winter so as not to interfere with the side wings of the snow plows. This



Boston & Maine R. R.—Cattle-guard and Wing Fence.

style of apron is adapted to northern New England, where cattle do not trouble during the winter season, and where it is desirable to incommode the snowplows as little as possible.

The wing fence stops with the face of end post 7 feet from the rail head. The apron is built on one vertical and one inclined piece of post. The cleats and rails are all 1 in. by 8 in., which is the material of the wing fences. The two pieces of post are cut from a regular fencepost, hence the only special stock is the eye-bolt hinge. Square stock would no doubt be better than round for the nailing pieces, but this would necessitate ordering special stock, which Roadmasters dislike to do.

The surface cattle-guard shown with the fence is slightly different from those shown by the Committee. The slats are sawed without waste from 4-in. round edge plank. They are 8 ft. long, rodded near each end through short fillers and secured by lag screws to the ties. They are made up in the right widths to fill between rails and outside and are regularly taken up during the winter. The apron fences and guards when removed are stored in the fence corner, so that no breakage or confusion occurs from removal.

These guards are not entirely efficient, but the loss from cattle crossing them is much more easily borne than the trouble and expense of keeping up the track over pitguards. It is probable that cattle are not as troublesome in New England as in many sections of the country, and the guard here shown may not be suitable where stock runs at large. Neither would the detachable feature of the apron fence be of value where snowplows are not numerous.

Mr. F. P. Gutelius (Canadian Pacific—by letter) :—The Committee recommends that woven-wire fences be composed of No. 7 top and bottom wires, No. 9 intermediate wires and No. 11 stays.

It would appear that these sizes were determined upon the required strength of a new fence, and that the question of the life of the fence had been overlooked. The life of any well-designed fence is equal to that of its shortest lived member. Therefore, as soon as the No. 11 stay is rusted out, the fence will require renewal.

It is suggested, therefore, that the stay wires be increased to No. 9.

Mr. H. Pierce (Chesapeake & Ohio—by letter) :—In the plan of cattle-guard presented by J. P. Snow, the arrangement for detachable apron seems a neat one and I should suppose would be of value in a snowy country. It is not needed here. My experience indicates that a slot cattle-guard is more effective if the length is increased to ten or even twelve feet.

Mr. C. H. Ewing (Philadelphia & Reading—by letter) :—Referring to cattle-guard recommended by Mr. J. P. Snow, my experience with wooden guards is that they do not offer the protection that some forms of iron guards do, but usually give very fair service. They should be made in sections so that they can be removed in pairs to permit tamping of the track. It is also desirable to remove the wings where Russell wing snowplows are used. The plan submitted covers these features, and I believe to be good construction for this type of guard.

Mr. A. S. Baldwin (Illinois Central) :—This report is divided into two sections; the first section relates to fences, and the second section relates to cattle-guards. I presume it will be proper to discuss one section at a time. I will make a statement, preliminary to the report of the Committee to the effect that the Committee recognized at the outset that the public is largely dependent upon the manufacturers for the articles they use, in the way of both fences and cattle-guards, and it was the aim of the Committee to get together as large an amount as possible of statistical information that would be of assistance in enabling a purchaser to determine what kind of an article he was getting from the manufacturer when he made his purchase. There are, for instance, a very large number of fences on the market, the cuts of which have very much the same appearance, but, as a matter of fact, there is a vast deal of difference between the articles when you come to purchase them. The gauge of the wire in the stiffener counts for a great deal, and the spacing of the stiffener counts for a great deal. In the barbed wire fence the spacing of the barbs, and the question as to whether the barbs are single or double-pointed, while apparently not being very material, cut a very large figure when the fence is used by the mile. So the Committee endeavored to get from the manufacturers of these proprietary articles information that would enable them to put all of these articles on a fair basis for comparison. The manufacturers were, therefore, requested to submit sketches of their articles and give certain information. For instance, to give for each fence illustrated the weight per foot, per rod and per mile; the spacing of the stiffeners, and the weight and gauge of all the wires.

With reference to cattle-guards, the manufacturers were required to give the grade of the material used in the guards, the amount of projection above and below the ties, and the widths of the sections. These were presented in a previous Bulletin (No. 34), without comments, favorable or otherwise, from the Committee, so as to enable each purchaser to determine exactly the kind of article he was getting.

The attention of the Committee was called by Mr. Cushing, of the Pennsylvania Lines, to the necessity of some investigation in regard to the so-called process of galvanizing. It is generally admitted that this process is largely a failure. There is great complaint from all the railroad companies as to the durability of the wire they are purchasing. Galvanizing, as applied to the wire which we purchase in the market, is a misnomer. The correct process of galvanizing, I believe, is first to coat the metal with tin and immerse it in a bath of molten zinc. As a matter of fact, the manufacturers have neglected entirely the previous tinning in the galvanizing process, and all of the wire which we purchase as galvanized wire has merely had an immersion in a zinc bath. I would like Mr. Ericson, vice-chairman of this Committee, who was chairman of a subcommittee, to make a statement to the Association relating to this subject. I think it will be interesting for the members to know the results which were arrived at.

Mr. E. G. Ericson (Pennsylvania Lines):—The Committee has not expended sufficient time in investigating this question of galvanizing to be able to give you a complete report on the matter. We have, however, consulted quite extensively with manufacturers and also with experts in chemistry. The present practice in galvanizing wire for fence purposes consists in giving the iron wire or steel wire a coating of zinc, putting the wire through a bath of molten zinc. The theory is that the naked iron, exposed to the atmosphere, readily corrodes, and that iron covered with zinc will not corrode. This is, perhaps, correct, when applied to the subject of protecting iron simply from the action of moisture or air which is not filled with sulphurous smoke. When we come to the conditions under which most of our fences operate, namely, exposed to coal gas, in which we find large quantities of sulphurous and sulphuric acid, that theory does not hold. Rather than protecting the wire, the zinc coating assists, under these conditions, in the deterioration of the wire. Under such conditions it would be much better and much more economical to use the naked wire without any zinc covering. If we want any protection under these conditions, we should go to tin; we should have the wire covered by tin instead of zinc. The manufacturers say this can be done, and they do it and use the wire for certain purposes, but not for fences. They tell us that they think our fences will cost us more if built of that kind of wire than we would save by the longer life, and that it, therefore, would not be an economical measure. We are not prepared to say whether this conclusion is right. We have these figures to offer you. The cost of the spelter or zinc at the present time is about 4½ cents per pound, and the cost of tin at present 29 cents per pound. The manufacturers say that this difference in cost will result in an increase in the cost of the wire of about one cent per pound. As to how much longer the life would be, no one so far has been willing to state.

It is impracticable, as has been suggested by some people, to give a heavier coating of zinc at the wire, inasmuch as the wire, when used for fences, would be bent and twisted, sometimes quite severely, and when the coating becomes a certain thickness it will not stand this bending, and consequently cracks and exposes the naked wire.

Mr. Baldwin:—The conclusions in regard to fences and cattle-guards will be found on page 13. I ask the permission of the Association to add to these conclusions what should have been included originally, that is, under fences add another recommendation: "(4) The Committee recommends the adoption of the definitions and specifications as given on pages 5 and 6." Under cattle-guards, add another recommendation: "(2) The Committee recommends the adoption of the definitions and specifications as given on pages 10 and 11." Will it be in order to move that, Mr. President?

The President:—Yes; I think that depends on the discussion anyhow. The Committee presents specifications and definitions both for fences and cattle-guards. The discussion of these definitions and specifications will probably be very interesting, and we do not wish to railroad any of these

reports through. We would like to know what the desire of the convention is as to how the report shall be considered, whether we shall adopt the conclusions, or whether we shall take up the report in regular order and consider each clause of the specifications and definitions. What is the pleasure of the convention as to how this report shall be considered?

W. F. Tye (Canadian Pacific):—I move that the report be considered clause by clause.

(The motion carried.)

The President:—You will find the definitions on page 5. The Secretary will read them, and, unless objection is offered, when each definition is read it will be considered as adopted.

The Secretary:—"Bottom Wire.—The horizontal wire at the bottom of a fence."

(Adopted.)

The Secretary:—"Brace.—A piece of timber or metal placed diagonally or horizontally between the end post and the next intermediate post for the purpose of maintaining the end post in an upright position."

Mr. J. G. Sullivan (Canadian Pacific):—It seems to me they limit that a little too much. We are putting up fences where we are putting in stretchers and ratchets, and put in braces, but these could not be considered as end posts. We would use intermediate braces in that case. A brace, whether it happens to be at an end post or an intermediate post, is a brace just the same.

Mr. Baldwin:—It was the idea of the Committee that when a post was braced it was practically an end post—at the end of a certain section of fence. The fence may continue beyond that point, but it constitutes the end of the section when you brace it. That is the idea, but the Committee is willing to insert a qualification.

Mr. John V. Hanna (St. Louis & San Francisco):—It will serve every purpose and make the matter perfectly clear if we say "between any post and the next post to it." That will take care of any end post or intermediate post braced at any point.

Mr. Baldwin:—The Committee accepts that.

Mr. R. C. Barnard (Cleveland, Akron & Columbus):—I do not like the definition of bottom wire as "the lowest horizontal wire at the bottom of a fence." I think a better definition would be "the lowest horizontal wire of a fence."

Mr. Baldwin:—The Committee will accept that change.

The Secretary:—"Brace Panel.—A panel in which a brace or tie, or both, are introduced."

(Adopted.)

The Secretary:—"Cleat.—A piece of wood or metal fastened transversely to the sides of a post below the ground line to give it greater stability."

(Adopted.)

The Secretary:—"End Post.—A post at the end of a line of fence."

Prof. W. D. Pence (Purdue University):—In carrying out the idea

of the chairman, perhaps we should introduce after the word "line," the words "or section."

Mr. Baldwin:—The idea of introducing "section" there was to draw a distinction between what constituted an end post of a fence and an end of a section; whereas the end post is, strictly speaking, the end of the fence. As it is, it draws a better distinction between the end of a section and the end of the fence.

Mr. J. G. Sullivan:—I think Professor Pence's criticism of the definition is well taken; but, in view of the new definition of the brace, it does not seem that it is necessary to change the definition of end post.

Mr. Baldwin:—The Committee is willing to accept that amendment.

The Secretary:—"Fence.—A line of posts and rails or wires, or of boards and pickets; a wall, hedge, ditch, trench, bank, or anything that serves to guard against unrestricted ingress and egress."

Mr. C. S. Churchill (Norfolk & Western):—I do not like the word "ditch" put in as a fence. It serves the purpose, but it is going too far in a definition of fence.

Mr. Baldwin:—That is the definition given in nearly all the dictionaries. I was surprised to find it, but thought it was sufficiently good authority to justify its introduction. The Standard Dictionary gives it and the Century Dictionary gives it.

The Secretary:—"Fence Post.—An upright piece of timber, metal or other material used as a support for the attachment of the horizontal members of the fence."

Mr. W. McNab (Grand Trunk):—It seems to me we are going into a little too much detail in the definitions of some of these members. I hardly think it necessary to define a fence post. A gate post and an end post are certainly fence posts. I think we are sufficiently acquainted with a fence post without having to express it in the language given in these definitions. I merely make this suggestion.

The President:—I think the object of that is that the end post and the gate post are usually larger and longer than the others, and necessarily must be considered separately.

Mr. McNab:—The question is as to the necessity of a definition of fence post.

The President:—The necessity arises from the fact that if you want to draw specifications, you will have to differentiate between fence post, end post and gate post.

Mr. Walter G. Berg (Lehigh Valley):—In that case, then, referring to the last remark of the President, should not the definition bring out and indicate the distinction between end post, fence post, etc.? In other words, with regard to these definitions, not only in this report but in all reports, we ought to understand what we are aiming for. It seems to me we are aiming to establish technical definitions for use in contracts and engineering specifications and descriptions and works so as to avoid confusion as to what is intended. A great many of these definitions, possibly some in this report—I know it is so in the case of some of the other reports—are definitions such as a professor would draw up based on

the use of the word in the English language. For instance, the chairman of the Committee has stated why he included the definitions of ditch and trench as a fence, because the definition appeared in certain leading dictionaries. I question whether that is the aim of our definitions, to give the exact meaning of the word according to the dictionaries. We wish to define technically what the word represents in our engineering works and instructions. For instance, under this heading, "fence post," the President has just remarked that the necessity for having a definition of fence post is to distinguish between end post, fence post and other posts, on account of difference in size and length. Then, it seems to me, the definition, if put in this report, should bring that out. We are not defining the words "fence post," but the *use* which we wish to apply in our technical work to the words "fence post," "end post," and other classes of posts.

Mr. G. A. Mountain (Canada Atlantic):—I think the definition is well founded. We have fence post, gate post and end post. We make specifications for fence posts of certain dimensions, percentage of end posts for certain purposes, and gate posts, longer and larger. I think the definition is well taken.

The President:—The specifications on page 7 will show the necessity for defining these different parts of the fence. I agree with Mr. Berg that what we want are definitions that will express their technical meaning from our standpoint rather than from the standpoint of the dictionaries, and I believe that a shorter definition of fence could be secured.

Mr. McNab:—What I want to bring out, with regard to the definitions of end post, fence post and gate post, is that the sum and substance of the definition as given is that they are posts, and it seems to me there should be a little more qualification. If the idea is to incorporate their use in specifications, there should be a little more concise detail given in these definitions.

The President:—Will the gentleman give us his ideas as to how that clause should be amended?

Mr. McNab:—I refer that to the Committee. I have not gone into the detail.

Mr. Berg:—It has just been stated that there should be a proper distinction between end post, fence post and gate post. Under the definition of "end post" we define it as a post at the end of a line of fence. Under the head of "fence post" a definition is given which would apply equally well to gate post or end post; there is nothing there to distinguish a fence post from an end post or a gate post. The definition would apply to any post in a line of fence. To carry out the idea that we wish to distinguish between end post, fence post and gate post, I would suggest we say that a fence post is an intermediate post other than a gate post or an end post.

Mr. Baldwin:—You still have to define your end post and gate post. The Committee thinks the distinctions or definitions suggested by Mr. McNab and Mr. Berg relate to specifications rather than definitions. These specifications refer to certain differences between different kinds of posts, and the definitions are given of these posts, in order that you

may know what the specifications refer to and that there can be no ambiguity.

The President:—I suggest that "intermediate post" is defined further on in the definitions.

(No action taken on the suggestions.)

The Secretary:—"Fence Staple.—A metal device, in the shape of the letter 'U' with ends sharpened, for fastening the horizontal members of the fence to the post."

(Adopted.)

The Secretary:—"Gate.—A movable barrier consisting of a frame or structure of wood, metal or other material swinging on hinges or pivots for closing a passage or opening in a fence."

Mr. Barnard:—Does not the Committee consider a gate that would slide back as a gate? They say "swinging on hinges or pivots." How about a gate that slides back?

The President:—Will the Committee include sliding gates in the definition?

Mr. Baldwin:—The Committee will accept that suggestion and alter the clause. The definition will read: "A movable barrier consisting of a frame or structure of wood, metal or other material for closing a passage or opening in a fence."

The Secretary:—"Gate Brace.—A piece of wood or metal serving the purpose of stiffening the frame of a gate."

(Adopted.)

The Secretary:—"Gate Frame.—The sustaining parts of a gate, fitted and framed together, to which the other horizontal and vertical members are attached."

(Adopted.)

The Secretary:—"Gate Hinge.—A device for attaching a gate to a post and upon which the gate swings."

(Adopted.)

The Secretary:—"Gate Latch.—A device for fastening the swinging end of a gate to a gate post."

Mr. E. DB. Brown (Lehigh Valley):—I would move that it read "A device for fastening one end of a gate to a gate post."

Mr. Hanna:—I would suggest "the free end."

Mr. J. G. Sullivan:—With a sliding gate, one end has a swinging or sliding adjustment in place.

Mr. Baldwin:—Both are circumscribed by the post in exactly the same way; one end is bound when the gate is open and the other end is open when the gate is closed.

The President:—The suggestion is to strike out the words "the swinging" in the definition.

Mr. D. MacPherson (Canadian Pacific):—I think the motion to strike out the word "swinging" covers all possible cases and makes it consistent.

Mr. H. G. Kelley (Minneapolis & St. Louis):—I think Mr. Hanna's suggestion is worthy of thought. As amended, it would read "A device for fastening the free end of a gate to a gate post." The hinge end of a

swinging gate is fastened to the gate post, and in the sliding gate one end is hung to a gate post, and this would not be precise. The gentleman who suggested "the free end" comes more nearly to the truth.

The President:—Gates slide both ways sometimes.

Mr. Hanna:—I suggest when the gate slides both ways and has two free ends, it should have two latches.

Mr. Berg:—I suggest the word "locking" in place of "fastening."

Mr. Baldwin:—I do not think that will overcome the difficulty.

The President:—The motion is to strike out the word "swinging."

Mr. MacPherson:—I think the word "end" covers all cases. The latch is, of course, put on the proper end.

Mr. Baldwin:—The Committee suggests "A device for fastening one end of a gate to a gate post."

The President:—I think "A device for latching a gate" would be better.

(The motion of Mr. Brown was lost.)

Mr. Berg:—I move that it read: "A device for locking a gate."

Mr. Barnard:—I question whether "latching" could necessarily be considered as locking.

Mr. Berg:—Perhaps the word "restricting" would be better than locking.

Mr. Barnard:—I suggest that the word "fastening" be used instead of "locking."

Mr. Berg:—I accept the amendment.

Mr. Hanna:—I do not believe we add very much to the clearness of the definition by that; what we want to get at in the latching is the fastening of the end of the gate which is not fastened or held by hinges. We want to distinguish in some way, and I believe the simple word "fastening" is hardly enough. I think we should adopt the definition as it stood, or that "free," substituted for "swinging" end, would bring us nearer to what we want to say.

Mr. Tye:—I move that the word "swinging" be stricken out and the word "free" be substituted.

(The motion carried.)

The Secretary:—"Gate Post.—An end post to which a gate is hung or latched."

Mr. Tye:—I move that the word "end" be stricken out, and the definition read, "A post to which a gate is hung or latched."

(The motion carried.)

The Secretary:—"Intermediate Post.—Any post used between end posts."

(Adopted.)

The Secretary:—"Intermediate Wire.—Any horizontal wire coming between the top and bottom wire."

Mr. Berg:—I suggest we substitute "located" for "coming."

Mr. Baldwin:—The Committee accepts that.

The Secretary:—"Panel.—A section of fence between two adjoining posts."

Mr. McNab:—I would like to ask the Committee if they considered the word "two" in that definition?

Mr. Baldwin:—It is redundant; we will strike it out.

The Secretary:—"Stay.—A form of timber, metal or other material, whether vertical or inclined, serving the purpose of keeping the horizontal wires the proper distance apart and stiffening the fence."

(Adopted.)

The Secretary:—"Stay Wire.—A stay formed of wire."

(Adopted.)

The Secretary:—"Tie Wire.—A wire in tension between the end post and the next intermediate post used to assist the brace."

Mr. Churchill:—I move to take out the words "the end" and substitute the words "any two." That makes it correspond with the definition of "brace."

Mr. Ericson:—The Committee suggests we strike out the word "intermediate" in that definition, so that it will read, "any post and the next post."

Mr. Churchill:—If my change is adopted, the definition will read: "A wire in tension between any two posts used to assist the brace."

(Mr. Churchill's motion was adopted.)

Mr. Barnard:—While I do not agree with the Committee in the necessity for all these definitions, yet, as they have given us definitions of "bottom wire" and "intermediate wire," as well as using these terms in their specifications, they should, to be consistent, give us a definition of "top wire." I move that the Committee include such a definition at its convenience.

(The motion carried.)

Mr. Sullivan:—I think there is one definition we require, as we use the expression in our specifications, and that is "anchor post."

Mr. Baldwin:—The Committee submits the following definition of "top wire:" "Top Wire.—The highest horizontal wire of a fence."

(Adopted.)

Mr. Sullivan:—How about "anchor post?"

Mr. Baldwin:—The Committee is not prepared to submit a definition of "anchor post" offhand. It makes it necessary to define "anchor."

Mr. Hanna:—In view of the change made in the definition of "tie wire," we should go back to "brace" and make that read something like the definition of "tie wire." I suggest, if the Committee will accept it, that a change of that kind might be made without a motion.

The President:—Will the gentleman suggest how he wishes to amend that? Do you make a motion to reconsider that definition?

Mr. Hanna:—Yes.

(The motion to reconsider carried.)

Mr. Baldwin:—The Committee is willing to rewrite that definition. We are not prepared to present it now. We will take that up later and present it at another time.

The President:—We will now take up the specifications, and the Secretary will read the first clause.

The Secretary:—"Fence posts can be made of wood, steel, concrete, burnt clay, or combinations of concrete and burnt clay with steel."

Mr. McNab:—I ask if there is any objection to substituting the word "may" for the word "can," so that the sentence will read: "Fence posts may be made of wood," etc.?

(Amendment adopted.)

The Secretary:—"Fence posts made of steel have been in use for a number of years. The experience so far has been that they can not, even with frequent painting, be made durable enough to be economical."

Mr. Berg:—When these specifications were drawn, there was no conclusion or recommendation that the specifications should be accepted. The specification, as here presented, is partly descriptive and partly an actual specification. It seems to me a paragraph like that just read should be omitted if it is to be adopted as a specification. I make a motion to that effect.

Mr. Barnard:—Can we not carry it further and strike out the next paragraph also?

The President:—Will the Committee offer a suggestion to strike out all three of the paragraphs?

Mr. Baldwin:—Yes, sir.

Mr. Tye:—I think these paragraphs contain very good information, and I would suggest that, instead of striking them out, we put them into some other part of the report.

The President:—It is suggested that they be transposed to the descriptive part of the report.

Mr. Berg:—I ask the chairman of the Committee, after looking over this specification, if he considers that this specification as here presented is in shape for us to adopt as a specification, and to give out. It does not seem to me it was drawn with that idea in view, especially in view of the fact that no conclusion or recommendation was embodied in the report that it should be adopted. Interspersed throughout the specification are some very valuable items of information, but still they are not of such a character as to be considered a suitable specification. I would ask the chairman to state whether he considers it in shape for us to discuss it with a view to its adoption as a specification, or whether the discussion should not, preferably, turn on giving views and opinions relating to the subject, and leaving the actual adoption of the specifications as specifications for a subsequent meeting?

Mr. Kelley:—The point taken by Mr. Berg appears to be a very good one. If the chair will read over all the paragraphs coming under the heading "Specifications" it will be found that they are really information upon which a specification might be based, or requirements for a specification, and could not be adopted as a specification upon which a fence could be built, yet the information is excellent and something that I believe should not be omitted from this report. It appears in its present form that if the suggestions of the Committee for specifications be accepted, then, in a future report, a precise specification upon which a fence could be built could be presented.

Mr. Barnard:—I move an amendment to the motion that, instead of striking out the three paragraphs, the heading be changed from "Specifications" to "Suggestions for Specifications," and print the matter under that head.

Mr. Berg:—I move an amendment to the motion that the subject-matter under the head of "Specifications" for fences be received as a progress report and referred back to the Committee.

(The motion was carried.)

The President:—We will pass from the specifications for fences to a consideration of the subject of cattle-guards.

Mr. Tye:—I wish to ask the Committee to give us some information on the breaking strength of fence wire in their specifications.

The President:—The Committee will take cognizance of the request and furnish the information.

Mr. Baldwin:—The Committee would like to get some suggestions from the members of the Association about this matter of specifications for fences. These specifications are of a very general character, and were intended to be. There are no two sections of the country in which exactly the same kind of fence would suit the conditions; no two railroads that build exactly the same kind of fence; and if you try to draw up any specifications—close and hard specifications for fences—they will simply be thrown out, because, unless you go into a great variety of fences, which would make the report very voluminous, particularly with reference to specifications, you are not going to suit anybody. It is a matter of fact that this report really represents, as Mr. Hanna stated, information on which to base a specification, and the idea was to place before the members of the Association just as much information as it was in the power of the Committee to give to aid them in drawing up specifications for the particular kind of fence suited to the particular locality in which the fence was to be built. I would like to know if it is the desire of the Association that this Committee shall select a certain kind of fence that it desires to recommend, and draw up specifications for that style only. I think it would be a mistake to go into very close details on this question, because I do not think it would meet with very general favor. The country is too large and conditions too diversified, and I believe we are doing better in submitting this matter just in the shape of information. The Committee would be very glad to have some suggestions from the members of the Association.

Mr. Tye:—The road with which I am connected, the Canadian Pacific, traverses a great variety of country, and I think we meet probably as many different conditions as most of the roads. We designed but two different styles of fences; one intended to turn cattle only, in such country as our Northwest, similar to the American Northwest, and to a great extent similar to the American Southwest, and we have another style of fence which is intended to turn small stock, such as sheep and hogs, and we find that these two different styles of fence answer our conditions very well, and it is my opinion they would probably answer conditions generally.

Mr. Berg:—In answer to the question of the chairman of the Committee, it seems to me that is largely the province of the Committee, and it is their pleasure to decide what is the best form in which to put these specifications; in other words, if it is a tough problem, it will be all the more merit to them to solve it and to whip the matter into proper shape. Therefore it must, to a large extent, be left to them how far they can go in drawing and recommending to this Association, for adoption, a specification for fences, and how far it should go into details, and how much of it should be of a general character. I think there are certain general conditions and characteristics which could be embodied in a specification for fences, and then, under separate headings, the particular conditions and characteristics of certain classes of fences could be specified. Then a company desiring to make use of these specifications would have, so to say, a draft or outline of how to draw up specifications for their own particular needs. The important matter would be to give an outline under the detailed subheadings of the particular class of fences. It seems to me on those lines the Committee might turn out a general fence specification that would be very serviceable.

Mr. Hanna:—I think the remarks of Mr. Berg are right in line, that it would be a good thing for this Committee to prepare a specification of a desirable form of fence. In that connection it seems to me the form of fence would be affected by the laws of the different States, to some extent, and it would be very valuable information if the Committee could present some kind of synopsis of the laws relating to fences in the different states. It may take a good deal of time to do this, but it would eventually become a stock of information which would be of very great value.

The President:—That has already been done, and the laws relating to fences in nearly every State have been published in Bulletin No. 34. The Committee informs me that the matter has been brought up to date. The chair suggests that the members take this matter under consideration and write the Committee any suggestions they may have to make as to what they would like to have the Committee consider with regard to specifications.

Mr. Kelley:—In line with the remarks of Mr. Berg, suggesting that it is practicable and desirable to formulate a general form of specifications for fences, it is my opinion there are certain features of fence construction which would be common to all fences, pertaining principally to the quality of workmanship. The features that would change for the different states and different localities would be the material of which the fence posts are made, the spacing of the posts, and the kind of wire that is attached to them. In my opinion, that can be provided for in the specifications. The spacing of the posts can be left blank, if necessary, in the recommended form of specifications, allowing each railroad company to insert the number of feet apart that they desire to have the posts spaced. They could also put in their own specification the kind of wire to be used. In some territories the roads are only required to use four-strand

barbed wire, in other places seven-strand barbed wire, in other places a woven wire is required; but these are details which each railroad company could insert itself in its specification, provided that the general form of the specification and the quality of the workmanship are clearly specified and set forth in a standard form of specification.

Mr. Baldwin:—This report contains recommendations on the part of the Committee as to size of wire to be used for two different kinds of fences—a hog-proof fence and a cattle fence, for both a woven wire and a barbed wire. It gives a recommendation for spacing of posts. It also gives a distinct recommendation as to the use of woven wire in preference to barbed wire. It might be possible to condense this, and I think it would have been the better plan to have eliminated the descriptive matter and reduced it to a strict specification. These are questions which will probably have to be passed on by the convention sooner or later.

The President:—The question is on the motion to receive this as a progress report and refer it back to the Committee.

(The motion carried.)

The President:—That motion applies only to the specifications for fences, as I understand it. We will now take up the conclusions under fences, and the Secretary will read the first conclusion.

The Secretary:—"The use of woven wire in preference to barbed wire for railroad fences."

The President:—Any discussion on the first conclusion? If not, we will consider it adopted.

The Secretary:—"The use of a heavier pattern of woven wire than has generally been adopted."

Mr. Tye:—Conclusion No. 2 seems rather vague. If they had some weight of woven wire that they would recommend, it would seem to me better. They do not say what weight they have found in use, and one would not therefore understand what they recommend.

Mr. Baldwin:—On a preceding page there is a distinct recommendation as to the weight of wire. Preliminary to the discussion of that, I will state what the motives of the Committee were in deciding that question. The wires for top and bottom wire are very much heavier than are generally used. Inquiries made by the Committee show that woven wire generally was giving poor satisfaction. It is subject to very rapid corrosion—the bottom wire particularly, and as a rule the bottom wire is very light—so the Committee went to work to get a fence in which the top and bottom wires are much heavier than now, that is, a No. 7 wire. The aim is to get a fence very durable with no increase in cost, and that explains why there was such a heavy top and intermediate wire, heavier than generally used. The spacing of the posts will make up a good deal of the cost and make the fence about the cost of the best fence now built.

Mr. Tye:—In line with those remarks, the Committee recommends for stay wires gauge No. 11. They could hardly claim, could they, that that was an increase in weight over and above those in use.

Mr. Baldwin:—No; that is about the general use of a stay wire.

Mr. Tye:—In some of our fences we use a No. 7 for stay wires.

Mr. Ericson:—Not in woven wire fences.

Mr. Berg:—The conclusion drawn is framed as a generality to express the general idea that we ought to use heavier wires. I think if it is drawn for that purpose it is all right. If it was to be detailed, then we would have to go into a very large amount of detail, and it would lose its force. I think what the Committee was aiming at, what they wished to have us endorse, is the general idea that we are not using heavy enough wires.

The President:—That seems to be the intention. Is there any further discussion?

(Conclusion No. 2 was adopted.)

The Secretary:—"The use of a heavy smooth wire, or a plank, at top of barbed wire fence."

Mr. McNab:—I would like to ask the ideas of the Committee in regard to this smooth wire at the top and a plank at the top and the respective order in which they are placed in the conclusion, what necessity there is at the top for these respective adjuncts? There are some sections of the country where one condition would apply and some sections where it would not.

Mr. Baldwin:—The top wire with the barb is the one on which cattle are most likely to be injured. Horses and cows sufficiently strong to put their heads over the wire will do so, and endeavor to get grazing on the outside, and much the greater injury to stock comes from top wire, and while the Committee recommends against the use of barb wire, it recommends that when the barb wire is there, there shall be that much protection to stock by giving it a protection against the top wire.

Mr. Kelley:—The use of a smooth woven wire on top is good, and if we could maintain our fence with that type of construction I personally would be very glad to do so, but my own experience is that we can not. About four years ago I put up about three hundred miles of a woven wire fence, forty-nine inches high, of the standard weight of wire. I have since that time been obliged to put a barbed wire on top of that through every farm or pasture where there were cattle. Cattle would put their heads over it and tear it down. The posts were twenty feet apart. The farmers also assisted in tearing it down by climbing over it. The next year I put in probably about two hundred miles of woven wire fence, the wire thirty-two inches high, and on top of that put two barbed wires, and I have had no case of breaking down by cattle. They can not put their heads between the two barbed wires without cutting their necks, and they can not reach over it, and the lower barbed wire is close enough to the woven wire to prevent them getting through. So that I am afraid that the use of a heavy smooth wire on top, while it will protect the fence from parties climbing over it, will not protect the fence from damage by cattle, and that we may be forced to use barbed wire on top to protect the fence.

Mr. W. M. Camp (Railway and Engineering News):—I think that plank or board at the top of the fence is preferable to a smooth wire, so that cattle can see it at night, and will not be so liable to run into the fence. Is there any significance in placing "wire" before "plank?"

Mr. Baldwin:—No significance.

Mr. R. Montfort (Louisville & Nashville):—We have had no difficulty with a fence with ribbon wires on top and the balance of the fence barbed wire, and we have thousands of miles of it.

Mr. W. S. Dawley (Chicago & Eastern Illinois):—We have exactly the same trouble Mr. Kelley speaks of. I am building to-day the same kind of fence he is.

The President:—This is very important, and we want your experience. We would like to hear from other members.

Mr. W. C. Cushing (Pennsylvania Lines):—We always used to build barbed wire fences, and I think from the standpoint of economy and from the position of the railroad company it is a much better fence than the woven wire fences. I do not think the woven wire fence is an economical fence in maintenance and durability. We have been obliged to use the woven wire fence in many instances, because of legislation, and there is a bill now before the Ohio State Legislature which compels the use of this plank on top of the barbed wire fence the Committee is speaking of, but allows no substitution of heavy wire. It distinctly says it must be a plank. That is simply, as I understand it, to enable cattle to see the fence and avoid injury. It is generally conceded that stock of all kinds do not see the ordinary wire fences very clearly. The object is to make it more visible to them. I think a barbed wire on top is a very good thing to prevent the cattle from breaking the fence down, and when protected by a board it is allowable under the laws of most of the states.

The President:—We have for about twenty years been using a flat ribbon wire at the top, and in fact it was used at the bottom also. I do not know that it has been entirely effective in allowing the cattle to see it, but there is one peculiarity about it, and that is that the galvanizing on it is intact to-day. I would like to have the sub-committee looking into this galvanizing question tell me why that is.

Mr. Baldwin:—It looked into that, and the reason it did not recommend ribbon wire was that every one we heard from in regard to the ribbon wire spoke of its rapid deterioration.

The President:—I want to furnish the Committee with samples of wire that I know to have been in use for twenty years, and the reason I know it is that we have not purchased any in twenty years. Is there any further discussion on conclusion No. 3?

(There being no further discussion, conclusion No. 3 was adopted.)

The President:—The next is conclusion No. 4, but which I presume the Committee now withdraws.

Mr. Baldwin:—Yes.

Mr. Berg:—Does not the Committee recommend that the definitions be adopted?

Mr. Baldwin:—Yes.

Mr. Berg:—I move that conclusion No. 4 be added to cover the definitions adopted on fences.

(The motion carried.)

The President:—We will now take up the question of cattle-guards.

The Secretary:—"Apron.—The flaring panel of fence set parallel with the track to make connection between the cattle-guard and the wing fence."

Mr. Camp:—Is it necessary that the panel shall flare? Sometimes it does not flare, as I understand it. I would suggest that it read, "A leaning or flaring panel fence."

Mr. Baldwin:—The idea of the Committee was that flaring covered that. The Committee would be glad to receive instructions in regard to that.

The President:—The Committee holds that a panel that leans flares.

Mr. Barnard:—I would make the motion that the words "to make connection" be eliminated, my idea being that the apron is not always connected with the cattle-guard.

(The motion carried.)

The President:—We will consider the definition of "apron" adopted as amended.

The Secretary:—"Cattle-Guard.—A barrier used at the intersection of a line of fence with a railroad track to prevent the passage of live stock along the track."

Mr. H. M. Waite (Cincinnati, New Orleans & Texas Pacific):—Under "apron" you have the term "wing fence;" under "cattle-guard" you say "line of fence." Should not that be "wing fence?"

The President:—Yes; the point is good.

(The definition of "cattle-guard" was adopted as amended.)

The Secretary:—"Filler.—The piece of timber, metal or other material used between the slats composing a section to space and stiffen them."

(The definition was adopted.)

The Secretary:—"Section.—A group of slats or strips which go to make up a cattle-guard. Ordinarily four, but sometimes three, sections are required to make one complete guard."

The President:—I would suggest to the Committee that they say "surface cattle-guard."

Mr. W. S. Kinnear (Michigan Central):—I would suggest that we use the word "cattle-guard" in the definition of the word "filler."

The President:—The question is on the adoption of the word "surface."

Mr. Baldwin:—The Committee accepts that suggestion.

The Secretary:—"Slat.—A strip of wood or metal, to be used singly or in groups, to make up sections of a cattle-guard."

Mr. Barnard:—I suggest that we use the word "surface" in the definition, as was done in the preceding definition.

The President:—That is accepted by the Committee.

Mr. Barnard:—I would also like to make another suggestion. I

do not understand how we are going to use a strip of wood singly to make a section of guard. It says, "A strip of wood or metal, to be used singly or in groups."

Mr. Hanna:—I have seen slats used in connection with pit-guards. I hardly think we should restrict the use of the word.

Mr. W. B. Hanlon (Baltimore & Ohio):—They speak here of metal and wood. We have on exhibition here a guard made of terra-cotta; that ought to be included in the material.

Mr. Baldwin:—That does not come under the head of "slat."

The President:—It was suggested that we insert the word "surface" in front of the last words "cattle-guard." The Committee has accepted that.

Mr. J. G. Sullivan:—There is a little ambiguity here. The definition of "wing fence" is given, and then the definition of "cattle-guard." In our country we have a good many cattle-guards that would not be cattle-guards according to this definition. We have them where our right-of-way is not fenced, and where the line fences cross the track.

The President:—Do you not consider that portion on the right-of-way as a "wing fence?"

Mr. Baldwin:—That is the construction the Committee put upon it.

Mr. J. G. Sullivan:—If it is so understood, let it go.

The Secretary.—"Wing Fence.—The line of fence making connection between the apron of the cattle-guard and the right-of-way or line fence."

(The definition of "wing fence" was adopted.)

The President:—The next is "Specifications."

Mr. Baldwin:—The Committee proceeded on the idea that the first duty of a railroad company was the safety of the passengers; the second duty was the safety of its employés, and the third duty the return of interest on the capital invested. All of these features are involved in the substitution of surface for pit cattle-guards. It is admitted that a pit cattle-guard introduces certain elements of danger, and it was for that reason that the surface cattle-guard was recommended. The conditions in the North are entirely different from what they are in the South so far as cattle-guards are concerned. Nearly all of the States of the North have fence statutes, which prohibit the roaming at large of cattle; in the South there are no such statutes, and a large number of the poorer class of people have cattle that roam at large all the time and forage for a living, and these cattle get to be as expert in crossing cattle-guards as it would be possible for any animal to get, because the right-of-way represents the only good grazing sometimes in large sections, and an intolerable condition has arisen with almost all the Southern railroads. The cattle have been allowed to roam at large, and it is impossible to find any form of cattle-guard that will turn these cattle, and at the same time the railroad companies are held liable for damages to crops and to cattle on account of failure to provide a cattle-guard which will turn cattle. Some of the roads do not wish to return to the use of the pit-guard on account of the danger connected with it.

The President:—The conclusions have no descriptive matter interjected and are in good shape to consider. We will take up conclusion No. 1.

The Secretary:—"The use of the surface in preference to the pit cattle-guard."

The President:—The question is on the adoption of the recommendation of the Committee as to the use of the surface cattle-guard in preference to the pit cattle-guard.

Mr. Tye:—Can the Committee tell me whether the laws of any of the States require that pit-guards must be used?

Mr. Baldwin:—I do not recall that any of the laws specify a pit guard. They all refer to it as a cattle-guard.

Mr. Tye:—Do they not state that the guard must be satisfactory to a commission where they have commissions; if so, have the commissions ever decided it? In our country the law is something to that effect, but the question as to what is a satisfactory guard has never yet been decided by a commission.

Mr. Baldwin:—I think there is not a State in which this question is referred to a commission, and it is one of the recommendations of the Committee that the subject should be taken up and legislation secured, if possible, enabling the railroad companies to refer the different kinds of cattle-guards to an authoritative commission to pass upon. This would give the railroad companies some ground to stand upon when these frequent suits are coming up. In the State of Michigan—and that is the only State we have been able to find that has any such statute—the railroad companies are permitted to refer to the commissioner of railroads their designs for cattle-guards, and he passes upon that design. A part of the report of the Committee gives the form of endorsement that has been given by the commissioner of railroads of Michigan to what is really the cheapest form of slat cattle-guard. One member of the Committee, Mr. Williams, tells me that in every case in which suits have come up on account of cattle getting over this guard they have been able to present this form of endorsement by the commissioner of railroads, and it has been accepted as sufficient, and I believe he claims not a suit has been decided against them as long as they have used that guard; and something of that kind, it seems to the Committee, is the only thing that offers any solution to this situation. The railroad companies will adopt anything that is efficacious and not dangerous. I have made tests of every form of surface cattle-guard put on the market, and, so far as my experience is concerned, it is a question of degree as to how many cattle are going to cross. The cattle go over all of them. For a month or so the cattle are afraid of a new guard.

The President:—The question is one of such importance that the chair will not be content with simply a negative passage of it. We will have a motion and vote on this question in expressing our preference for a surface or pit guard.

Mr. Baldwin:—If it is the sense of the convention that the surface

guard is the most safe and proper one, that is the best authority the railroad companies can have to act upon.

Mr. Churchill:—I agree with the chairman in his statement. In most of the States, especially in the South, the original use of the pit-guard made that the acceptable cattle-guard, and when any railroad attempted to adopt the surface guard they were forced to defend themselves at law and show it to be a cattle-guard. This was our condition until within a few years, when, fortunately, we won a very important suit before one of the leading judges of the State of Virginia, who decided that a surface guard was a legal cattle-guard, his ruling being, in brief, that as the Norfolk & Western Railway was maintaining cattle-guards of a pattern used and approved by standard railroads in Virginia and elsewhere, they were performing their duty.

The President:—Any further discussion as to the use of a surface cattle-guard?

(There being no further discussion, the recommendation was adopted.)

Mr. Berg:—Would it not be desirable to have it recorded that the vote was unanimous?

The President:—The chair heard no negative votes on the subject, and without objection it will be recorded as unanimous. We will next take up the specifications. The Secretary will read clause 1.

The Secretary:—"(1) It should be so constructed as to overcome the objectionable features of the pit-guard, particularly so far as endangering trains is concerned. Projecting surfaces which would be liable to be caught by dragging brake or other rigging should be avoided."

Mr. McNab:—I would suggest that the word "must" be substituted for the word "should."

Mr. Baldwin:—We do not say that they must be so constructed. These specifications cover what the Committee believe to be preferred cattle-guards. We are using and will continue to use for a good many years cattle-guards that do not need this requirement; so the Committee intentionally used the word "should" all the way through.

Mr. McNab:—I think the word "must" would be better. We are endeavoring to insure the property of the railroad company against damage, and it seems to me it is emphasized more by putting in the word "must," and makes it definite.

Mr. Baldwin:—If you were going to draw up specifications for the purchase of a lot of cattle-guards from some firm, would you insert the word "must?" How many proposals would you get to furnish cattle-guards if you put the word "must" in there?

Mr. McNab:—I merely made a suggestion.

(Specification No. 1 was adopted.)

The Secretary:—"(2) It should be of such construction as not to endanger employés who are compelled to pass over it in the discharge of their duties."

Mr. McNab:—I do not think any inference ought to be thrown out that might lead anyone to believe that the employés are forced by the

railroad company into danger, and I would suggest the words "are compelled to" be eliminated. I think it should be "of such construction as not to endanger employés who pass over it in the discharge of their duties."

Mr. Baldwin:—The Committee accepts that amendment.

The Secretary:—"(3) It should be effective as to all kinds of live stock, and at the same time have no parts which would catch and hold stock that might endeavor to pass."

(Specification No. 3 was adopted.)

The Secretary:—"(4) It should be reasonable in first cost, durable and easily applied and removed, so as to allow repairs of track at minimum expense."

(Specification No. 4 was adopted.)

The Secretary:—"(5) It should not rattle during the passage of trains."

(Specification No. 5 was adopted.)

The President:—We have practically passed unanimously conclusion No. 1. The Committee desires a second conclusion added, as follows: "The Committee recommends the adoption of definitions and specifications for cattle-guards as given on pp. 10 and 11."

(Conclusion No. 2 was adopted as read.)

REPORT OF COMMITTEE NO. IV.—ON RAIL.

To the Members of the American Railway Engineering and Maintenance of Way Association:

The Board of Direction gave the Committee on Rail the following instructions for this year's work:

Drop tests. Shrinkage clause. Confer with Track Committee with regard to standard drilling. Submit revised specifications, if deemed advisable, supplying marginal index.

Mr. Garrett Davis, chairman of the Committee on Track, sent out a circular letter to railway companies with regard to standard drilling, and on September 28, 1903, called a joint meeting with the Committee on Rail in Chicago. Four members of the Track Committee and three of the Rail Committee met on that date to consider and report on the replies received. The chairman of the Committee on Track has made a full report on the proposed standard drilling (see Bulletin 46, pp. 43-49), which will be considered by the Rail Committee at a meeting in Chicago on the day before the report of the Rail Committee is presented to the convention for discussion.

The attached preliminary rail specifications are based on the former proposed specification of the Association, taking into account the discussions at the convention and the rail specifications suggested by Mr. Trimble, former chairman of the Rail Committee. These specifications were sent out to each member of the Committee, with a request that he vote on the points at issue, which are given alternatively. The result of that vote is given below.

These specifications will be further considered and discussed at the meeting of the Committee next March in Chicago, when it is to be hoped that definite conclusions will be reached, or some compromise made on the points under consideration. At that time the specifications will be put in better shape before being presented for discussion.

SUMMARY OF CONTENTS OF PREVIOUS REPORTS.

1900: The preliminary report contained an historical sketch in regard to the evolution of the rail in present use; a brief discussion of rail sections in use in this and foreign countries; a discussion of the chemical constituents and mechanical treatment of rail, and length of rail. No conclusions or recommendations were embodied in the preliminary report. **(Pp. 112-119, Vol. 1, 1900.)**

1901: In the report for 1901, the Committee recommended the use of fewer sections, the weights recommended being 60, 70, 80, 90 or 100-pound sections. The standard length of rail recommended, 33 ft., was adopted by the convention. The following table, showing proper allowance for expansion for 33-foot rail was adopted: Twenty degrees below to zero, 5-16-in.; zero to 25 deg., ¼-in.; 25 deg. to 50 deg., 3-16-in.; 50 deg. to 75 deg., ⅛-in.; 75 deg. to 100 deg., 1-16-in.; over 100 deg., rail to be laid close without bumping. (Temperature—Fahrenheit.) (Pp. 188-199, Vol. 2, 1901.)

1902: The Committee submitted standard specifications for steel rails (Bessemer process), which were adopted. The following recommendation was made and adopted: "We recommend that the foregoing specification be adopted as standard for use of members of this Association, that it be printed and distributed to the members, and that the members of the Association obtain the information suggested in regard to chemical composition and shrinkage, and submit the same for use of the Committee on Rail, from time to time, as it is secured." (Pp. 200-206, Vol. 3, 1902.)

1903: The Committee presented only a verbal report of progress (Pp. 281-282, Vol. 4, 1903.)

RESULT OF VOTE ON SPECIFICATIONS.

POINTS ON WHICH VOTES WERE REQUESTED.	Votes for.
One drop test on *each blow* of steel *without* a shrinkage clause....	One
One drop test from *each blow* of steel *with* a shrinkage clause. (6⅛ in. for 100-lb. 33-ft. rail).....	Four
One drop test from every *fifth blow* of steel *without* a shrinkage clause	Two
One drop test from every *fifth blow* of steel *with* a shrinkage clause. (6⅛ in. for 100-lb. 33-ft. rail).....	Two
Heights of drop tests as given in *Schedule* (*a*), paragraph No. 3. (19 ft. for 100-lb. rail).....	Three
Heights of drop tests as given in *Schedule* (*b*), paragraph No. 3. (22 ft. for 100-lb. rail).....	Six
Standard lengths of rails 33 ft. varying by even feet *down to 27 ft.*	Five
Standard length of rails 33 ft. varying by even feet *down to 24 ft.*.	Four

STANDARD SPECIFICATIONS FOR BESSEMER STEEL RAILS.

Process of Manufactu

(1) (a) The entire process of manufacture and testing shall be in accordance with the best current practice, and special care shall be taken to conform to the following instructions:

(b) Ingots shall be kept in a vertical position in the pit heating furnaces until ready to be rolled, or until the metal in the interior has time to solidify.

(c) No bled ingots shall be used.

(d) Sufficient material shall be discarded from the top of ingot to insure sound rails.

Chemical Compositio

(2) Rails of the various weights per yard specified below shall conform to the following limits in chemical composition:

	50 to 59 Pounds. Per cent.	60 to 69 Pounds. Per cent.	70 to 79 Pounds. Per cent.	80 to 89 Pounds. Per cent.	90 to 100 Pounds. Per cent.
Carbon	0.35-0.45	0.38-0.48	0.40-0.50	0.43-0.53	0.45-0.55
Phosphorus, shall not exceed	0.10	0.10	0.10	0.10	0.10
Silicon, shall not exceed	0.20	0.20	0.20	0.20	0.20
Manganese	0.70-1.00	0.70-1.00	0.75-1.05	0.80-1.10	0.80-1.10

Drop Test (one from each heat)

(3) One drop test shall be made on a piece of rail not less than four feet and not more than six feet long, selected from each blow of steel. The test piece shall, preferably, be taken from the top of the ingot. The rail shall be placed head upwards on the supports, and the various sections shall be subjected to the following impact tests under a free falling weight:

	Weight of Rail. Pounds per yard.	Height of Drop. Feet.
*(a)	45 to and including 55	15
More than	55 " 65	16
More than	65 " 75	17
More than	75 " 85	18
More than	85 " 100	19
*(b)	45 to and including 55	15
More than	55 " 65	16
More than	65 " 75	18
More than	75 " 85	20
More than	85 " 100	22

If any rail break when subject to the drop test, two additional tests will be made of other rails from the same blow of steel, and if either of these latter tests fail, all the rails of the blow which they represent will be rejected, but if both of these additional test pieces meet the requirements, all the rails of the blow which they represent will be accepted.

*See amendments, page 469.

Drop Test (one from every fifth heat).

*One drop test shall be made on a piece of steel not less than four feet and not more than six feet long, selected from every fifth blow of steel. The test piece shall, preferably, be taken from the top of the ingot. The rail shall be placed head upwards on the supports and the various sections shall be subjected to the following impact tests under a free falling weight:

	Weight of Rail. Pounds per yard.	Height of Drop. Feet.
(a)	45 to and including 55	15
More than	55 " 65	16
More than	65 " 75	17
More than	75 " 85	18
More than	85 " 100	19
(b)	45 to and including 55	15
More than	55 " 65	16
More than	65 " 75	18
More than	75 " 85	20
More than	85 " 100	22

If any rail break when subject to the drop test, two additional tests will be made of other rails from the same blow of steel, and if either of these latter tests fail, all the rails of the blow which they represent will be rejected, but if both the additional test pieces meet the requirements, all the rails of the blow which they represent will be accepted. If the rails from the tested blow shall be rejected for failure to meet the requirements of the drop test as above specified, two other rails will be subjected to the same tests, one from the blow next preceding and one from the blow next succeeding the rejected blow. In case the first test taken from the preceding or succeeding blow shall fail, two additional tests shall be taken from the same blow of steel, the acceptance or rejection of which shall be determined as specified above, and if the rails of the preceding or succeeding blow shall be rejected, similar tests shall be taken from the previous or following blows, as the case may be, until the entire group of five blows is tested, if necessary.

Shrinkage Allowance (for rails 33 ft. long).

*(4) The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass the temperature of the rail will not exceed that which requires a shrinkage allowance at the hot saws of 6 in. for 85-pound and 6⅛ in. for 100-pound rails, and no artificial means of cooling the rails shall be used between the finishing pass and the hot saws.

Drop Testing Machine.

(5) The drop testing machine shall have a tup of two thousand (2,000) pounds weight, the striking face of which shall have a radius of not more than five (5) inches, and the test rail shall be placed head upwards on solid supports three (3) feet apart. The anvil block shall weigh at least twenty thousand (20,000) pounds, and the supports shall be part of, or firmly secured to, the anvil. The report of the drop test shall state the atmospheric temperature at the time the test was made.

*See amendments, page 469.

(6) The manufacturer shall furnish the inspector, daily, with carbon determinations for each blow, and a complete chemical analysis every twenty-four hours, representing the average of the other elements contained in the steel, for each day and night turn. These analyses shall be made on drillings taken from small test ingot. Chemical Analyses.

(7) Unless otherwise specified, the section of rail shall be the American Standard, recommended by the American Society of Civil Engineers, and shall conform, as accurately as possible, to the templet furnished by the railroad company, consistent with paragraph No. 8, relative to specified weight. A variation in height of one sixty-fourth (1-64) of an inch less, or one thirty-second (1-32) of an inch greater than the specified height, and one-sixteenth (1-16) inch in width will be permitted. The section of rail shall conform perfectly to the fishing dimension. Section.

(8) The weight of the rails will be maintained as nearly as possible, after complying with paragraph No. 7, to that specified in contract. A variation of one-half (½) of one per cent. for an entire order will be allowed. Rails shall be accepted and paid for according to actual weights. Weight.

*(9) The standard length of rails shall be thirty-three (33) feet. Ten per cent. of the entire order will be accepted in shorter lengths, varying by even feet to twenty-seven (27) feet. A variation of one-fourth of an inch in length from that specified will be allowed. Length

*(9) The standard length of rails shall be thirty-three (33) feet. Ten per cent. of the entire order will be accepted in shorter lengths, varying by even feet down to twenty-four (24) feet. A variation of one-fourth of an inch in length from that specified will be allowed. Length.

(10) Circular holes for splice bars shall be drilled in accordance with the specifications of the purchaser. The holes shall accurately conform to the drawing and dimensions furnished in every respect, and must be free from burrs. Drilling.

(11) Rails shall be straight when finished, the straightening being done while cold, smooth on head, sawed square at ends, variation to be not over one thirty-second (1-32) of an inch, and prior to shipment shall have the burr occasioned by the saw cutting removed and the ends made clean. No. 1 rails shall be free from injurious defects and flaws of all kinds. Finish.

*(12) The name of the maker, the weight of rail and the month and year of manufacture shall be rolled in raised letters on the side of the web, and the number of blow shall be plainly stamped on each rail in at least two places not subsequently covered by the splice bars. Branding.

(13) The inspector representing the purchaser shall have free entry to the works of the manufacturer at all times when the contract is being filled, and shall have all reasonable facilities afforded him by the manu- Inspection.

*See amendments, page 469.

facturer to satisfy him that the finished material is furnished in accordance with the terms of these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment.

No. 2 Rails.

*(14) No. 2 rails will be accepted up to five (5) per cent. of the whole order. Rails that possess any injurious defects, or which for any other cause are not suitable for first quality, or No. 1 rails, shall be considered as No. 2 rails; provided, however, that rails which contain any physicial defects which impair their strength shall be rejected. The ends of all No. 2 rails shall be painted in order to distinguish them. Rails rejected under the drop test will not be accepted as No. 2 rails.

Respectfully submitted,

Wm. R. Webster, *Chairman;* Consulting and Inspecting Engineer, Philadelphia, Pa.

R. Montfort, *Vice-Chairman;* Chief Engineer, Louisville & Nashville Railroad, Louisville, Ky.

F. E. Abbott, Inspecting Engineer, Illinois Steel Company, Chicago, Ill.

G. Bouscaren, Consulting Engineer, Cincinnati, O.

S. M. Felton, President, Chicago & Alton Railway, Chicago, Ill.

Robert W. Hunt, Consulting Engineer, Chicago, Ill.

J. T. Richards, Chief Engineer, Maintenance of Way, Pennsylvania Railroad, Philadelphia, Pa.

R. Trimble, Chief Engineer, Maintenance of Way, Northwest System, Pennsylvania Lines, Pittsburg, Pa.

G. B. Woodworth, Rail Inspector, Chicago, Milwaukee & St. Paul Railway, Chicago, Ill.

Committee.

*See amendments, page 470.

AMENDMENTS.

Test from heat).

(3) One drop test shall be made on a piece of rail not less than four feet and not more than six feet long, selected from each blow of steel. The test piece shall, preferably, be taken from the top of the ingot. The rail shall be placed head upwards on the supports, and the various sections shall be subjected to the following impact tests under a free falling weight:

	Weight of Rail. Pounds Per Yard.	Height of Drop. Feet.
	45 to and including 55	15
More than	55 " 65	16
More than	65 " 75	18
More than	75 " 85	20
More than	85 " 100	22

If any rail break when subject to the drop test, two additional tests will be made of other rails from the same blow of steel, and if either of these latter tests fail, all the rails of the blow which they represent will be rejected, but if both of these additional test pieces meet the requirements, all the rails of the blow which they represent will be accepted.

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(4) The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass the temperature of the rail will not exceed that which requires a shrinkage allowance at the hot saws of 6 in. for 85-pound and 6⅛ in. for 100-pound rails, and no artificial means of cooling the rails shall be used between the finishing pass and the hot saws. The above shrinkage allowance may be varied, if necessary, so as to give a finishing temperature of not exceeding 1,600 degrees Fahrenheit at finishing rolls for mills rolling from reheated blooms, and not exceeding 1,750 degrees Fahrenheit at finishing rolls for mills rolling direct from the bloom to finished rail.

th.

(9) The standard length of rails shall be thirty-three (33) feet. Ten per cent. of the entire order will be accepted in shorter lengths, varying by even feet to twenty-seven (27) feet, and all No. 1 rails less than 33 feet shall be painted green on the end. A variation of one-fourth of an inch in length from that specified will be allowed.

Omit second paragraph (9).

ding.

(12) The name of the maker, the weight of rail and the month and year of manufacture shall be rolled in raised letters on the side of the web, and the number of blow shall be plainly stamped on each rail where it will not subsequently be covered by the splice bars.

(14) No. 2 rails will be accepted up to five (5) per cent. of the whole order. Rails that possess any injurious defects, or which for any other cause are not suitable for first quality, or No. 1 rails, shall be considered as No. 2 rails; provided, however, that rails which contain any physical defects which impair their strength shall be rejected. The ends of all No. 2 rails shall be painted white in order to distinguish them. Rails rejected under the drop test will not be accepted as No. 2 rails. No. 2

DISCUSSION.

Mr. Wm. R. Webster (Consulting and Inspecting Engineer):—The Committee, at a meeting yesterday, decided to adopt the greater height of drop test called for in Article 3. Therefore (a) is crossed out. They decided to call for one drop test on each heat of steel; the paragraph referring to one test of steel on each fifth heat is crossed out. In paragraph 4, referring to the shrinkage, they add the following: "The above shrinkage allowance may be varied, if necessary, so as to give a finishing temperature of 1,600 degrees Fahrenheit at finishing rolls for mills rolling from reheated blooms, and 1,750 degrees Fahrenheit at finishing rolls for mills rolling direct from the bloom to finished rail." The second paragraph, marked 9, is crossed out. We adopted a standard length of 27 feet, that is, for the shorter lengths, and after the words "27 feet" in the first paragraph 9, we add "and all rails less than 33 feet in length shall be painted green on the end." In that connection, in paragraph 14, referring to No. 2 rails, it should read, "and the ends of all No. 2 rails shall be painted white." With these exceptions the report stands as printed. We have had referred to us the matter of standard drilling. We will take that up with the Track Committee. This Committee feels that it does not care to recommend any standard drilling, but would like the opinion of the members of the Association in regard to standard drilling proposed by the Track Committee.

The President:—The first matter to be considered is the change proposed by the Committee in striking out paragraph (a) and substituting (b). Attention is called to the fact that the height of drop will be increased from 19 to 22 feet. Discussion on the motion of the Committee to make this change is in order.

Mr. R. Trimble (Pennsylvania Lines):—When the first draft of the specifications was submitted to this Association it contained the height of drop mentioned in section (a), and that was criticised as not being a very scientific arrangement, because the height of drop, 19 feet, provided for a section of rail 85 to 100 pounds, did not bear the proper relations to the height of drop, 15 feet for 45 or 55 pound rails, and in order to make that relation nearer to what it should be, table (b) was prepared. If anyone would go to the trouble of determining the moment of inertia of those different sections they would still find we do not have the same relation between the height of drop and the moment of inertia right straight through, depending on the sections of the rail. But it is believed that table (b) is more nearly right than table (a), and in striking out the (a) table you eliminate the letter (b), so there will be one set of figures in the specifications.

Mr. W. F. Tye (Canadian Pacific):—Is it necessary that we pass on that? It seems to me the reason these different tables were given was on account of the differences among the Committee themselves, and now they have reconciled their differences and present this report as though that portion were not in it. Must we not consider this report as being with this left out?

Mr. Trimble:—That is right.

The President:—If the ruling is made in accordance with the Committee's suggestion, the clauses as changed will be adopted as a whole. This matter having been previously adopted by the Association, the Committee has no right to amend the specification without the permission of the Association. Therefore we will take the vote on this proposed substitute, unless there is further discussion on the matter. All in favor of the substitution of table (b) for table (a), as proposed by the Committee, will say aye.

(The motion carried.)

The President:—The next matter to be considered is the striking out of the clause relating to the drop test, one from every fifth heat, which is a necessary adjunct to the action taken with reference to the clause on the preceding page. Is there any discussion on the Committee's motion to strike out that clause?

Mr. W. M. Camp (Railway and Engineering Review):—With the first half of the table?

The President:—The entire clause, from the third line on the page down to the shrinkage clause. The Committee then proposes to adopt clause 3 in lieu thereof. All in favor of this recommendation to strike out this drop test clause on page 6 will say aye.

(The motion was carried.)

The President:—Clause No. 3, on page 5, is the clause the Committee desires to insert to take the place of the clause we have just dropped.

Mr. F. A. Smith (Roadmaster and Foreman):—The recommendation states not less than four and not more than six feet. That is quite a limit in the tests, which would show variable results. I recommend that it be made a precise figure—five feet, or whatever the Committee may think proper.

Mr. Webster:—That is merely the crop end of the rail. What difference does it make whether it is six feet or five feet? In that connection I would like to refer to paragraph 5, where it describes that the rail must be supported on supports three feet apart.

Mr. Smith:—I see that my suggestion was not necessary.

Mr. F. E. Abbott (Illinois Steel Company):—The report handed in by the Committee is a majority report. There is no formal minority report presented. The main question coming up in connection with paragraph 3 is whether or not there is any necessity for so many drop tests as are called for. It is hardly right to impose something on the mills that would not be altogether important, or from which the railroads would not derive any special benefit. The mills claim that one test in five is a

sufficient check against bad material, and, of course, the other side would claim that it is not. Under this paragraph it would seem well to bring out as clearly as possible what benefit, if any, is gained by increasing the number of drop tests There is a certain process that is followed in the steel coming from the mills which I doubt if the railroad engineers fully understand, and if they did fully understand it it might develop that many drop tests would not be required. There are some men present who are thoroughly posted in the practice of the mills, and if it is in order, it would perhaps be well to call on them for some information.

The President:—We would like to hear from Mr. John McLeod, of the Carnegie Steel Company, on this question whether we shall have a drop test from each blow or from a number of blows.

Mr. John McLeod (Carnegie Steel Company):—I do believe you are making a mistake in insisting on one test from each blow. I think it is a revolution to go from the present method of testing to the practice of one test for each blow of steel. This matter has been discussed several times by the manufacturers, and quite a number of the engineers, and it was developed in these discussions that one test in each five blows would amply test the material, because we believe that the selection of the test is a selection looking toward the assurance that you get uniformity in your resultant rails. In doing that it is necessary to test from the standpoint of the mixer, and if you would do that it would seem to me that you would have no danger of getting rails that were not satisfactory. I do not recall how many tons our mixer holds, but I think it is about 125 tons. I think the Illinois Steel Company's mixer holds 150 tons of molten metal. That is a pretty constant quantity. Therefore, if you get a test from each melt or each fifth melt, you are making two tests, checking the mixture twice. Should you happen to get a test which is not right, there is a specification in existence containing a clause allowing a test of the preceding melt and of the succeeding melt. If these tests show up badly, keep on going back until you pick out the bad material. It would seem to me it would be a step in the right direction to make more drop tests than have been made in the past, but I believe it is unfair to insist on so much of this test as is proposed in this paragraph. That means a test every three minutes for a straight ten hours each day. That is more time than our inspectors usually put in at a mill. They do not put in ten full hours, because they have their lunch hour. You can see that we would be up against it in piling up shipments if we should go to unnecessary extremes in the matter of these tests. We desire to meet you in anything you can do to enable you to criticise our products, as we know we have to stand back of the rails, and our credit is at stake; but we do not feel that you should impose a hardship upon us. We admit that you should criticise, but do not feel that the criticism should go any further than is absolutely necessary. I believe this clause, which requires a test from each blow, is going a step too far in entailing a hardship upon us. I would like to enter that mild protest against it.

Mr. Trimble:—I wish to ask Mr. McLeod two questions: First, how many tons of rails his company rolls in ten hours? Second, how much it would cost to keep up a continuous inspection, making a drop test every three minutes for ten hours?

Mr. McLeod:—We roll, say, 3,000 tons a day, roughly; in other words, we roll 100 to 110 blows of steel in each turn—call it 200 blows. I have taken the inspector's time on a basis of ten hours' work, and that would amount to twenty tests an hour. Of course, you can multiply drop-testing machines and multiply inspectors, and you will have to multiply both.

Mr. Trimble:—Would not two drop-testing machines do all the work?

Mr. McLeod:—I doubt if they would.

Mr. Trimble:—Three would, then?

Mr. McLeod:—Probably. But I do not think that is a question involved at all. If it is necessary, I do not think the manufacturers would hesitate about that expense.

Mr. Trimble:—I understand that expense comes from the railroad company, after all.

Mr. McLeod:—I have heard that legend mentioned before. I am not criticising this matter so much on account of that kind of expense, as from the standpoint of expense involved in the delay. If you are going to do this testing at all, you have to do it right. To do it right will entail a lot of unnecessary delay. One test in five blows would not involve any such delay.

Mr. Trimble:—I think the Association will get a better understanding of the situation by asking these questions and having a representative of the mills answer them. We have heard that it is going to delay the product at the mills by putting on these additional drop tests. If the mill does not have sufficient drop-testing machines to make tests of every heat then it will be necessary to provide additional machines to take care of the light increase in work without delay. The inspection and testing of the rails is a very small item of the cost of the rail, and the additional labor in making these additional drop tests is going to be a very small item and if, as Mr. McLeod says, the steel company has to stand the expense after all, their profit might be reduced five or ten cents a ton, but I feel quite sure that they have enough margin in present prices to stand this expense. Mr. McLeod makes a statement that the steel company, after all, stands back of its product. I do not know exactly what that means. A few years ago, our road had a guarantee of five years on the rail. If they wore out inside of that time the steel company gave us new rails to take the place of the wornout rails, but I do not understand that the steel company now guarantees any rails. We have many rails which wear out inside of two or three years, and the steel company does not stand back of the product and give us new rails for the worn-out rails, at least not with our company.

Mr. Webster:—I think it may be well to call attention to the fact that the Illinois Steel Company did for years make a drop test on every

heat of steel. I never heard that it delayed their output. It would be merely a matter of the inspector being on hand at the time when the drop tests were made. I think that part of the argument would be fully answered by the experience of that one mill.

Mr. Trimble:—Is not that the experience of the Lackawanna mill also?

Mr. Abbott:—If I understand the reason for making the drop test, it is to keep clear of brittle steel. The railroad engineers are fearful of getting rails on the track which will break. The loss of the rails is not the question. It would not cost the steel company very much to replace all the broken rails. The railroad companies do not care for the loss of the rails, but they do want to prevent, as far as possible, the rails breaking under the trains. That is the great danger in broken rails. What the trackmen want, if I understand it correctly, is to keep clear of brittle steel, and the object of the drop test would be to know that the run of the steel is satisfactory to them. I think Mr. McLeod did not explain quite fully so that the members who are not familiar with mill work would understand the process that is followed. The mixer is something that is in constant use. It is being refilled and drawn from all the time, and holds a certain number of tons—100 to 150—and a heat would consist of about ten tons. The gentlemen will understand that ten or twelve tons are drawn from the mixer, which contains from 100 to 150 tons, and you can easily see what portion of the metal coming from the mixer represents a heat. The drop test, as it has been practiced, will be a check on every fourth or fifth heat which comes from the mixer, the latter being constantly refilled and drawn from, and is not simply filled and then unfilled without any additional metal during the withdrawal. The point is, is the drop test of one heat in five sufficient to catch any bad material that comes along in the continuous process? The mills claim it is. Some of the railroad men claim it is not. The mills would not want to send out brittle rails. That would be the last thing they would want to do knowingly. They feel that one test in every five heats is a sufficient check against high phosphorus, and it can hardly be supposed that a single heat would be bad and the heat on either side of it would be good. It would extend through the heats, and they would catch the poor steel in one test in five. If the material were found to be bad in any heat it would be necessary to trace both ways from that heat until steel was found that would meet specifications and rails from the inferior heats would be rejected. This practice is required by standard specifications and is generally followed by the mills. As I said before, the steel mills would not want to send out brittle rails under any condition.

Mr. Webster:—I think both Mr. Abbott and Mr. McLeod are correct, in so far as the drop test on one heat of steel in five would be a check as far as the composition of the iron in the mixer is concerned, but they assume that the blowing of the steel, scrapping, and the whole process of making and rolling the steel, is uniform from the molten metal to finished rail. It is not uniform; it does vary. A drop test on each heat

of steel would check that as well as the finishing temperature of the rail. The Committee have merely given specifications embodying what they consider would produce a more satisfactory rail. It may be that experience will show that we need not test each heat of steel, and then we can let up on it, but we want the right to do it if it is necessary.

Mr. McLeod:—I would call attention to the fact that Mr. Webster's statement that the Illinois Steel Company was not delayed when it tested each heat of steel has passed by without criticism. Mr. Carhart, who has that portion of the Illinois Steel Company's affairs in his hands, is here, and I do not believe he will agree with that statement.

Mr. P. E. Carhart (Illinois Steel Company):—It is true, as Mr. Webster states, that we did at one time make a drop test on each heat of steel. To say that we had no delay is radically wrong, in that I can cite cases where we had from eighty to one hundred cars held from three to four days waiting the results of the drop test, because it was impossible to keep up with the mill, even though we were running the drop twenty-four hours per day. The practice of making one drop test on each heat was kept up by the Illinois Steel Company for eight years, and the breakages were so infinitesimally small that it was considered unnecessary to continue this practice, hence we changed to the standard practice recommended by the International Association for Testing Materials (to which many of your members belong), namely, a drop test on every fifth heat of steel; in case of breakage, the preceding and succeeding heats to be tested, thus fully protecting the purchaser. When you insist upon one drop test for each heat of steel, you are putting a hardship on the mill from which you are not going to derive a corresponding benefit.

Mr. Webster:—My statement was this—that both Mr. McLeod and Mr. Abbott were agreed that one test in five might be a check on the quality of the iron in the mixer, to show it was uniform, but in order for that to be an accurate check on each heat of steel, you had to assume that the blowing of five or six heats, with one heat tested, would be uniform, and that the finishing temperature would be uniform. That is a good deal to assume, and my contention is that a drop test on each heat of steel would check any irregularity in the blowing or in the rolling.

Mr. Carhart:—You may consider the mixer an equalizer in which all the casts from the different furnaces are so mixed together as to make a uniform grade of iron. The blower knows just how to treat it and get out a uniform product, hence I consider one drop test on every fifth heat sufficient protection.

Mr. R. Montfort (Louisville & Nashville):—How many drops do the Carnegie specifications contain?

Mr. McLeod:—Manufacturers' specifications?

Mr. Montfort:—Yes.

Mr. McLeod:—None at all.

Mr. Montfort:—That is the reason that this Committee adopted one in five—they think that one in five is better than none at all.

Mr. McLeod:—You are now going to test one in every blow.

Mr. Montfort:—We think conditions have changed so that we now demand one in every blow, which we could not do last year.

The President:—Is there any further discussion on this question?

Mr. Trimble:—I think Mr. Abbott knows how much it costs to make these drop tests, and perhaps he will tell us.

Mr. Abbott:—That does not enter into the question. It is not a question of cost. What the railroad men want is good rails, and they want assurances that they will not be brittle. That is the way I look at the drop test. You order a carload of links, and you test three links from the load, and it may be that the links on the other half of the load are defective and not satisfactory. It is not possible to test every link in the carload, and the manufacturers would claim that it is unfair. The steel company claims that a drop test in every heat is unnecessary, and if it is unnecessary, it means work that they do not want to do. They do not want to do unnecessary work to prove the material is good. If they can prove sufficiently that the number of drop tests which they advocate will give the railroad men the quality of rails they should have, that is sufficient—enough is enough.

Mr. C. A. Wilson (Cincinnati, Hamilton & Dayton):—We certainly want to get a better rail.

Mr. W. C. Cushing (Pennsylvania Lines):—The discussion has gone on the assumption that we are getting a good rail, and if we were getting a good rail, under present conditions, a test of one drop in five would be all that is necessary under those conditions. If such were the fact, I think we would all be very glad, indeed, to accede to the request that the test be limited to one drop in five, as we have no desire whatever to put any additional expense on the mills; but the contrary is the fact, and has been for the past four or five years.

I do not think we have received any worse rails in our history than we are receiving at the present time, and have been receiving for the past four or five years. We are now trying in our specifications to obtain better rails, and if this additional test will do it, we certainly want it, even if we pay more money for it; but I do not believe we are going to get it, even under the recommendation of the Committee. I am afraid there is something we have not yet hit upon which will enable us to get the quality of rails we should have. It is not a case of brittle rail any more, but a case more like a soft rail. Nearly all our troubles come from mashed heads, split heads, soft material, etc., and we have but very few broken rails with clean fracture. We find a great many piped rails among those that are reported. We certainly must have some way of getting a better rail than we are getting. The fact that we have had such poor rails for so many years has been leading many of our own men to inveigh against the American Society section of rails as being responsible for it, and the mills have encouraged that belief, much to our detriment, because it has not been backed up by any facts. I think it is an exceedingly important matter to be settled.

Mr. C. S. Churchill (Norfolk & Western):—I keep record of the breaking of rails on our road, and for several years in no case have I found a broken rail due to the chemical analysis. Breaking seems to be due to an incipient flaw in the rail which has been there for a long time; and, under these circumstances, I do not place very great weight on this drop test. Of course, if we should make a drop test on every rail as it comes to the railroad, then I believe we would have assurance like that secured by testing each link of a chain. My inspector has told me it would be a very difficult thing to apply the drop test to every heat. What we want to get is uniformity of the steel. I believe we should have the right to make as many tests as we see fit, to secure that result; but I agree with Mr. Cushing that the trouble we are having with rails to-day is primarily something which can not be corrected by the drop test—the rails are too soft. They will sometimes sliver very readily, and the drop test is not going to discover these defects to us. Therefore, I am not inclined to ask the mill man to do something that will not add to our benefit as users of material, but I do think that the paragraph should be so guarded, if we adopt the second one, that we can make as many tests as we see fit to get the result. What we want is good rails.

Mr. McLeod:—I quite agree with some of the remarks made by the gentleman who has just spoken, but rather disagree on one remark, and that is, if you should test every rail you would get somewhere near perfection. I do not believe anything of the kind. I do not believe the drop test is going to correct the trouble you are after. The trouble you are after has been indicated—too many piped rails. Manufacturers do not have to be told that. We are doing everything we can to prevent it, and believe we are taking steps in the right direction. The drop test will not correct that. Another thing—the rails do not wear quite as well as they should. We are taking steps to correct that. Mr. Webster's idea of the heat treatment of steel is a good thing, and we have attempted to use some of his ideas. For that reason I think you are trying to introduce a revolution into the thing, and will not get the result. You are causing a whole lot of trouble if you insist on a drop test of every heat, and I do not think you will get the result. I believe if Mr. Webster sent his man to our mill, he could pick out all the piped steel if he wanted to. I think I could.

Mr. Webster:—There is one matter which has been overlooked in the discussion, and that is, the trouble with the rails has been more due to the large grain in the head, on account of their being finished too hot in rolling. The drop test will detect that. The individual grains will be large, but there will be well-developed planes of cleavage between them, and the drop test will cause fracture. The drop test is a check on the finishing temperature. Rails finished at a low temperature make good wearing rails; rails finished at a high temperature make poor wearing rails. We may have gone to the extreme and asked too much, but we are willing to stand by it and modify it hereafter, if necessary.

The President:—All in favor of paragraph 3 on page 5 relating to the drop test, one from each heat, will say aye.

(The paragraph was adopted.)

The Secretary:—"(4) The number of passes and speed of trains shall be so regulated that on leaving the roll at the final pass the temperature of the rail will not exceed that which requires a shrinkage allowance at the hot saws of 6 inches for 85-lb., and 6⅛ inches for 100-lb. rails, and no artificial means of cooling the rails shall be used between the finishing pass and the hot saws.

"The above shrinkage allowance may be varied, if necessary, so as to give a finishing temperature of not exceeding 1,600 degrees Fahrenheit at finishing rolls for mills rolling from reheated blooms, and not exceeding 1,750 degrees Fahrenheit at finishing rolls for mills rolling direct from the bloom to finished rail."

Mr. Webster:—The President has asked me to explain what the object of the clause is. It is merely to guard against rails being finished too hot in rolling. The Pennsylvania Railroad years ago suggested that the rails should be finished at a dull red. It is pretty hard to tell what a dull red rail is and how to finish it. They have followed this up and introduced into their specifications the clause which we have adopted here—the additions we have made to it, the degrees Fahrenheit—and what Captain Hunt has in his specifications, and we want a rail finished at a low enough temperature to give you a good wearing rail. We have asked that from the manufacturers, and we have also asked them to show that it is a good rail by giving a drop test on each blow of steel; that means you will have to pay more for your rails to meet these conditions. That is, you should pay more, if you decrease their output by asking them to observe these requirements in the production of the rails.

The President:—Is there any discussion on the motion to add the following clause to specification No. 4 on page 6: "The above shrinkage allowance may be varied, if necessary, so as to give a finishing temperature of not exceeding 1,600 degrees Fahrenheit at finishing rolls for mills rolling from reheated blooms, and not exceeding 1,750 degrees Fahrenheit at finishing rolls for mills rolling direct from the bloom to finished rail."

(The motion to adopt the addition quoted was carried.)

The President:—On page 7 the Committee desires to strike out the second paragraph, numbered 9—there are two paragraphs numbered 9. It is also desired to add to the first paragraph No. 9 the following: "And all rails less than 33 feet shall be painted green on the end."

Mr. Abbott:—As to the question of lengths, the shorter length would be preferable to the mill, and it should also be considered by the engineers whether or not it would not help them out in a great many cases if the lengths were run down to 24 feet. It does not mean that a great number would reach that limit; probably a very small percentage would run below 27; but if it were stated in the specifications that 24-ft. rails would be accepted, it is barely possible that it would be an assistance to the engi-

neers who use the rails; that is, to avoid the necessity of cutting in fitting in switches and other places of a similar nature. I call attention to this, so that the members will think of it in voting.

Mr. G. B. Woodworth (Chicago, Milwaukee & St. Paul):—This refers to rails diminishing by even feet. In some cases railroads wish rails sawn to half feet, like 33½ feet, etc. Those would probably require a special mark. We are referring now only to rails diminishing by regular feet.

(The second paragraph No. 9 was stricken out.)

The President:—The next matter to be considered will be the addition of the following to the first clause 9, on page 7, to be added after the word "feet:" "And all rails less than 33 feet shall be painted green on the end."

Mr. Tye:—That means all No. 1 rails?

Mr. Webster:—Yes, this refers to No. 1 rails; we will refer to No. 2 rails in paragraph No. 14.

Mr. Tye:—You might have No. 2 rails shorter than 33 feet.

Mr. Webster:—They will all be painted white.

Mr. Tye:—Why not say No. 1 rails in paragraph No. 9?

Mr. Webster:—The Committee will accept that change and make it read: "And all No. 1 rails less than 33 feet shall be painted green on the end."

(The amendment was carried.)

The President:—The Committee desires to insert the word "white" in paragraph 14, to read: "The ends of all No. 2 rails shall be painted white in order to distinguish them."

(The amendment was adopted.)

REPORT OF COMMITTEE NO. II.—ON BALLASTING.

To the Members of the American Railway Engineering and Maintenance of Way Association:

A meeting of the Committee was held at the Association rooms, in Chicago, November 24, 1903. There were in attendance the chairman and Messrs. C. A. Paquette and W. W. Colpitts. A subcommittee, consisting of Mr. W. W. Colpitts, chairman, and Mr. G. M. Walker, Jr., was appointed for the purpose of preparing statements of cost of the different kinds of ballast.

Another meeting was held December 17. Those in attendance were the chairman and Messrs. C. A. Paquette and J. G. Sullivan.

The previous report was revised and prepared for printing in the Bulletin.

SUMMARY OF CONCLUSIONS OF PREVIOUS REPORTS.

1900: No conclusions were submitted in the 1900 report, the report being only an outline of the manner in which the Committee proposed to carry on its work in future. (Pp. 87-91, Vol. 1, 1900.)

1901: In its 1901 report the Committee confined itself to a consideration of what constitutes ballasted track, and submitted the following conclusion: "The materials used must be substantial, able to distribute the applied load over a large surface of the roadbed; they must be enduring, to resist, so far as possible, destruction from tamping and disintegration from age and weather; they must be of such character as will allow easy manipulation in lining and surfacing, and furnish proper drainage. In quantity, there must be a depth under the ties sufficient to transmit the applied load over a large surface of the roadbed and to provide a firm and uniform bearing for the ties, and to furnish thorough drainage. There must also be enough to fill in the track and construct the standard cross-section, so as to hold the track firmly and securely in position and aid in the drainage." The report was received as a report of progress, and referred back to the Committee for further consideration. (Pp. 59-63, Vol. 2, 1901.)

1902: The report for 1902 contained a discussion of the materials suitable for ballast—size, quality, etc.; ballasting; depth of ballast; ballast cross-section. Under the last-named heading, the Committee submitted the following recommendations: Rock Ballast: Depth below tie, eight to twelve inches; top surface of ballast, top of tie; slope of ballast, from top of tie at a point eight inches

outside of end of tie, at the rate of one and a quarter or one and a half to one. Gravel: For gravel containing an appreciable amount of clay and not easily drained under all conditions—depth under tie, from eight to twelve inches; top of ballast between rails, top of tie; top of ballast at end of tie, bottom of tie; slope to subgrade, two to one; for crushed and washed gravel, the cross-section for stone may frequently be used. Chats, Disintegrated Stone and Coarse Sand: Chats, disintegrated stone and coarse sand, which drain thoroughly—depth of ballast below tie, eight to twelve inches; top of ballast, from one to two inches above top of tie; top of slope, six inches beyond end of tie and even with the top thereof; slope, one and three-quarters to one to subgrade. The recommendations of the Committee were adopted. (Pp. 128-132, Vol. 3, 1902.)

1903: The report presented in 1903 did not come before the convention on account of lack of time. The following conclusions were submitted:

(1) That very little of the railroad mileage of the country can be maintained with any degree of satisfaction with the material that forms the roadbed. That almost always selected material that must be transported and put into the track is demanded.

(2) That there is a great variety of natural or artificial material obtainable in various localities that meets the demands more or less perfectly, and which it is good policy to use. That with the increase of speed and weight of engines and cars, the duty called for on ballast has grown more exacting, and materials that gave satisfactory results under 30,000-pound axle loads fail in a short time under 45,000 and 50,000-pound axle loads now coming into use.

(3) Except where an exceptionally good quality of gravel is obtainable, it is the opinion of the Committee that only stone ballast, made from hard durable stone and broken in sizes from ¼ of an inch to 1½ inches, and having a depth of twelve inches under the tie, resting on a firm, well-drained roadbed, will meet the requirements of roads with heavy traffic using maximum sized engines and having fast service.

(4) Ballast may fail from a variety of causes. It may not stand the action of the weather. This is true of most sandstones, some limestones, and most artificial ballasts. It may not have sufficient strength to resist crushing. This is true of some rocks, slags, cinders, chats and artificial ballast.

(5) It may wear out and become pulverized by the grinding of the pieces against each other and from frequent tamping. This is true of all ballast more or less, but is less marked in good stone and gravel than with other varieties.

(6) It may fail for want of weight or cohesion, and be blown or washed away, and fail to hold the tie in position. This is true of sandy gravel and chats.

(7) It may fail on account of a large part of the pieces being of a globular shape, with smooth surfaces, which allow the pieces to move as

well as the tie. This is generally true of beach or river bed gravel and some pit gravel.

(8) It may fail for want of support from below, especially if the top of the roadbed becomes concave and has defective drainage. This is a failure of the roadbed rather than the ballast.

HISTORICAL.

In the beginning of railroad construction it was natural to adopt some of the practices of the tram roads at that time in use in this and other countries, so we find that short rails were pinned to the top of stone posts, set in the ground, and even stone ties or "sleepers" were used, to which the rail was fastened. This was followed by strap-iron on wooden stringers, supported by transverse wooden mud sills. Even with these primitive forms of construction, it would seem the necessity for ballast was appreciated, though the present practices have been arrived at by a process of evolution.

In the natural order of things there was a constantly increasing demand for greater speed, an increase in moving load and a resulting change in the plan of construction to meet these conditions. Strap-iron on stringers gave way to the now universal rails and cross-ties, and this was a material improvement. While it served its purpose at the outset, like its forerunners, it had its shortcomings, which were made apparent as railroad transportation came into more general use. Line and surface could be maintained only by tamping, and it was seen that track laid in material that afforded ready drainage was less subject to trouble in these respects. It was found that sand gave better results than clay, and gravel than either, but unless the material under the track was so soft and boggy in wet weather that the rails went out of sight, no sand or gravel was hauled in by train. It was the custom in the early days, on many roads at least, to sink the ties for new track about three inches into the roadbed, the material excavated to make room for the ties being used to fill in between them. On comparatively few new roads was any effort made to regularly ballast the main tracks with gravel or other hard and easily drained material. Gradually the custom changed, the new tracks were laid down on top of the roadbed and the best material near at hand was hauled in for filling and surfacing. Gravel was generally the most available material, and it was distributed and used in places where the trouble from the natural material was greatest. When good gravel was not available, engine cinders were used, or stone, usually hand-broken, or refuse from mills and mines hard enough to resist crushing and the action of weather. This brought the various forms of slag and tailings into use. Eventually, the demand for ballast in sections of the country where little, if any, of the above-mentioned material was obtainable led to the manufacture of ballast from burnt clay, probably suggested by the manufacture of brick.

The practice first in vogue has not changed materially. The demand for better track has merely led to a more careful selection of material, even if it entailed a larger expense.

Of the railroad mileage in the country less than half has any ballast at all, and of that ballast more than half is gravel. Next in order of quantity come broken stone and the various refuse products of engines, mills, furnaces, etc., namely, cinders, slag, chats, and finally artificial ballast in the form of burnt clay. Small quantities are used of sand, chert, shells and disintegrated rock, occurring in natural deposits.

There appears to be but little written matter on the subject of ballasting, the literature not being as extensive as the importance of the subject would warrant. By the kindness of Mr. Octave Chanute, who made an abstract from some old works on railroads, which he had in his library, the following sketch was prepared:

The engineers who built the first railways attached very great importance to thorough ballasting, to its under-drainage, and to putting it in place before the "permanent way" was laid.

The mode originally adopted for supporting the rails was upon square blocks of stone, measuring 2 feet on the side and 1 foot in depth, upon which a cast-iron chair was fastened by wooden pegs, driven into holes bored in the stone block, the rail being fixed in the chair by an iron pin. (D. Lardner, "Railway Economy," 1850.)

These blocks were bedded with very great care, the greater portion of the ballast being first put in place, and the block bedded by being successively lifted by a hooked lever and allowed to fall until it had beaten its way into the gravel, thin layers of which were thrown in or taken out from time to time until the desired level was attained.

These blocks were not only heaved by frost, but they were found to produce a very rigid and destructive road; an extreme case of these attempts at making a railway "as smooth as a lathe bed" being that on the Manchester and Leeds line, in which the bottom of a rock cutting was dressed to a surface and the rails spiked directly to it. A few weeks' experience was sufficient to cause the rails to be taken up, and the stone block system was superseded by wooden sleepers, which were put into place with equal care.

In their report upon "The Permanent Way of European Railways," Messrs. Zerah Colburn and Alexander L. Holley devoted an entire chapter to Ballast, and said in 1858:

"The ballast has four distinct offices to perform. It must, first of all, distribute the bearing of the track over the surface of the earthwork; second, it must confine the track in place; third, it must secure the drainage of the surface, and, lastly, it must, by its character, give a certain elasticity to the road, uniformly intermediate between the rigidity of rock, or hard bottom of cuttings, and the weakness and softness of common earth."

The materials used for ballast on the English railways, as mentioned in the above report, were broken stone, gravel, burned clay (28 cents a cubic yard), cinders, sand, shells, broken bricks and culm, or coal waste, with a preference for the first two, and with careful attention to the drainage under the ballast.

It states that the English double track roads were generally ballasted 26 feet wide and 2 feet deep, using 10,000 to 12,000 cubic yards per mile, and the single track roads were ballasted 14 feet wide and 2 feet deep, taking 6,000 cubic yards per mile. In some cases 28 inches were put on. About one-half of the depth was hauled in before the permanent track was put down, the contractor using for this his own temporary rails and trains, and the additional ballast being put in afterwards.

Inasmuch as at that time (1858) ballasting had been but little used on American railroads, Messrs. Colburn and Holley called attention to

the fact that the cost of maintenance of the permanent way was very much greater here than on the English railways; for instance: "The London and Northwestern cost, in 1855, but one-fourth as much per mile run, for maintenance of way, as the great road of America—the New York Central. Had the cost of the latter been only double that of the former, the *saving* would have been $418,281, equal to a dividend of 1.8 per cent on the entire capital stock of the company."

Also, "The French double-track roads have averaged over $6,000 per mile for ballasting, and are maintained under their current traffic for $2,000 *less* per mile annually than the cost for the same mileage here."

They also stated that at that time the cost of gravel ballasting on the New York and Erie Railroad was 25.7 cents per cubic yard, that 169 miles were unballasted and 203 miles but half-ballasted, and that the engineer estimated that the increased wear of locomotives alone was sufficient to pay for completing the ballasting in about three years. On the Baltimore & Ohio Railroad broken stone ballast was costing about 40 cents a yard, and on the Pennsylvania Railroad the stone ballast was being charged up at 65 cents a yard, or $3,250 per mile (5,000 cubic yards) of single track.

These facts produced a great impression upon the American railroad managers of that day, and ballasting came into much greater favor. Mr. John B. Jervis, then the leading American engineer, devoted a chapter of his book, "Railway Property" (1861), to "Ballasting Track," recommending that it be from 1 to 2½ feet deep, and that light rolling stock be used until the road was well ballasted.

ANALYTICAL.

The prime object in the use of ballast is economy in the maintenance of line and surface. Good ballast will resist any tendency to displacement in the ties; will distribute the weight on the ties over the roadbed beneath them; will prolong the life of the tie and rail by conveying water away from them; will prevent the growth of weeds; will be sufficiently pliable to yield under the blow given the rails by moving load and thus prevent or lessen injury to them, and will be sufficiently elastic to return to its original position after the blow. No ballast, once put in place, will remain there, but must be restored to position by handling and tamping. To resist abrasion when handled, it must be hard and tough. Sharp corners increase friction between ballast and ties and between the particles of the ballast themselves. This in turn increases the capacity of the ballast to distribute weight over the roadbed. Large interstices between particles of the ballast facilitate the passage of water. The presence of chemical constituents, which injuriously affect tie or rail, tends to shorten the life of the latter. Good drainage tends to lengthen their life, to prevent churning and heaving by frost, and is the most important single requisite for economical maintenance.

The presence of earth, sand or fine particles of any sort tends to lessen friction between adjacent larger particles of the ballast and to prevent drainage, and is consequently detrimental. Chemical constituents which prevent growth of weeds may also injure ties and rail, and thus offset the advantage gained.

Heavy ballast is less easily displaced than light, hence weight is an advantage. Resistance to decay is essential on account of the expense

of renewal. Freedom from dust is desirable on account of comfort of passenger and the fact that dust increases wear of rail and rolling stock.

Having set forth the requirements of good ballast, it is next in order to consider the materials available for the purpose and see how nearly they fill them.

DEFINITIONS.

*Ballast.—Selected material placed on the roadbed for the purpose of holding the ties which are embedded in it in line and surface.

Broken or Crushed Stone.—Stone broken by artificial means into small fragments of specified sizes.

Chats.—Tailings from mills in which zinc and lead ores are separated from the rocks in which they occur.

Gravel.—Small worn fragments of rock, coarser than sand, occurring in natural deposits.

Sand.—Any hard, granular, comminuted rock material, finer than gravel and coarser than dust.

*Chert.—An impure flint or hornstone, occurring in beds or nodules in some stratified rocks.

Cinders.—The residue from the fuel used in locomotives and other furnaces.

Slag.—The waste product, in a more or less vitrified form, of furnaces for reduction of ore. Usually the product of a blast furnace.

Burnt Clay.—A clay or gumbo which has been burned into material for ballast.

*Gumbo.—Local name for a peculiarly tenacious clay, containing no sand

*Roadbed.—The graded surface on which the ballast is placed.

PLANS.

A number of ballast sections have been forwarded to the Committee from various sources, but on account of the difficulty in getting members of the Committee together and the lack of time in which to carefully go over them, no standard sections have yet been prepared for the consideration of the Association.

MATERIALS.

Crushed Rock.—In general, crushed rock comes nearer to filling the requirements of an ideal ballast than any other material. There are numberless varieties of rock of varying degrees of suitability for ballast purposes. Trap rock, granite, limestone and sandstone are all used. Some limestones and most sandstones make poor ballast, the latter being apt to wear into round form under tamping. Trap and granite are probably most satisfactory on account of hardness and toughness. The sharp corners of crushed rock produce friction between tie and ballast and thus

*See amendments, page 495.

hold the tie firmly. It acts well in distributing the weight over the roadbed and, when clean, gives good drainage. Rock seldom, if ever, contains constituents that have any chemical action on ties or rail, is hard and wears well and is heavy. It is pliable and elastic to a considerable extent, though not so much so as some other ballast. It will not entirely prevent growth of weeds, but is much more effective in this regard when clean than when the spaces are filled with dirt. This may occur by the fine, soft material of the roadbed working up through the rock or by the fall of cinders and dirt from trains from above. Complete filling of the spaces in crushed rock almost entirely destroys its usefulness, and it then becomes necessary to put new ballast on top of the old or to clean it. It is the Committee's opinion that it is cheaper to put in new ballast than to take out and clean the old, but an additional raise may be objectionable, particularly on the approach to a large bridge which can not be raised without great expense. The Committee invites discussion and information as to cost in this connection.

In crushing rock, many fine particles are made and usually screened out. The screenings must be disposed of in some manner, and the question of their suitability for ballast arises. They can be used in ballasting sidetracks, for leveling up between tracks in yards and for making platforms at unimportant stations. Used as ballast, they form a firm bed around the tie, but do not drain well, and consequently churn when wet. They are unsuitable for main line work. Specifications for stone ballast are submitted as follows:

SPECIFICATIONS FOR STONE BALLAST.

(1) QUALITY.—a. Stone should be durable enough to resist the disintegrating influences of the climate where it is used.

*b. It should be hard enough to prevent pulverizing under the class of traffic to which it is subjected.

c. It should break in angular pieces when crushed.

*(2) SIZE.—a. It is recommended that the maximum size of ballast shall not exceed pieces which will pass through a 1¾-inch ring, but a ring of 1½-inch diameter is preferred as the maximum measure of size.

b. It is recommended that the minimum size should not pass through a screen with ¾-inch holes.

(3) QUANTITY IN TRACK.—a. It is recommended that the minimum thickness of six inches under the tie be considered as ballasted track, but that a minimum thickness of 8 inches under the tie is preferred.

b. The extreme maximum thickness of 18 inches under the tie is recommended, with an ordinary maximum of 12 inches.

c. The upper surface of the ballast should be level with the top of the ties.

d. The upper surface of the ballast should extend 9 inches beyond the ends of the ties.

e. The slope should not be steeper than 1½ to 1

*See amendments, page 495.

GRAVEL.

Gravel, being a material deposited by nature, can not be procured ordinarily in a form which will satisfy definite specifications, therefore it is not worth while to draw them. The users of gravel ballast can only choose from the available deposits. The most desirable gravel ballast consists of a clean uncementing gravel, varying in size from coarse sand to stone 2 inches in diameter. With gravel of the above quality available, track can be held in line by shoulders of gravel put up to the elevation of top of tie and varying in width, depending on quality of road and traffic on same.

When it is necessary to use gravel containing clay or cementing material, where it is impracticable to wash same, it is better to depend on friction to hold track in line and place the ballast so that after settlement has taken place the ends of ties will not be imbedded more than one inch in ballast. (The Committee believes that the practice of surfacing new track with earth and loam is not economical when gravel is available with a haul of not over 100 miles.) The cost of renewing ties in gravel ballast varies with the frequency of train interruptions, from six to ten cents per tie in loose gravel, and from ten to twenty cents in cementing gravel.

SAND.

Coarse sand, where the particles are regular, with proper care will maintain track in good line and surface, but is liable to wash easily and is apt to blow in dry weather. Under rapidly moving trains it is dusty and has an appreciable influence in increasing the wear on the rails and rolling stock.

Sand which has a tendency to cement together is largely free from these detrimental influences.

BURNT CLAY.

The employment of burnt clay as ballast dates prior to 1857, but has not until recent years been used extensively in this country and has been practically confined to the great central basin, where sufficient quantities of good stone or gravel are not available without excessive cost. Its use has met with varying results, largely due to the quality of the material burned and the manner of burning. When the clay contains little sand and a sufficient quantity of fluxing material to produce a semi-vitreous mass, a very good quality of ballast will be produced, giving good results on roads with comparatively light traffic, and is to be commended because of the ease with which it can be worked. On roads with heavy traffic and heavy rolling stock burnt clay ballast has not given good satisfaction because of being too soft to stand the load and the disintegrating effect of the weather.

The clay may be burned in a kiln or in the open, in which case a length of pile of one-half mile is possible. The Committee suggests the following specifications for burnt clay ballast:

(a) The material should preferably be black gumbo from river-bottom lands. It should be free from sand or silt, and should be thoroughly tested in small test kilns before establishing a ballast kiln.

(b) The material should be burned hard.

(c) The fuel used must be fresh and clean enough to burn with a clean fire.

(d) The quantity of fuel and time of burning will vary with the moisture in the clay and the weather conditions.

(e) Burning should be done under the supervision of an experienced and competent burner.

(f) Care should be taken that fuel is always on hand when required.

(g) Ballast should not be loaded out of the pit hot.

(h) Absorption of water should not exceed 15 per cent.

When fuel is cheap and suitable material at hand, burnt clay ballast may be produced f. o. b. cars at about the cost of crushed rock. The cost of placing under track is much less than stone and it is for a time more easily maintained.

The cost of renewing ties in burnt clay ballast varies from seven to eleven cents per tie.

The life of burnt clay ballast varies from four to eight years, depending on the quality of the material and the amount of traffic it has to sustain. A table of cost will be found on pp. 38 and 39 of this report.

ENGINE CINDERS.

Since the advent of coal burning in locomotives, engine cinders have been used for ballast, and until within recent years as generally on main line as elsewhere. Roads having a total of 72,055 miles (46,894 miles main line), report 5,186 miles of cinders, 7,753 miles of stone, and 16,331 miles of gravel ballast.

Like gravel, cinders can not be produced to conform to definite specifications, but it may be remarked that if cinders are wet down immediately after being drawn, their quality as ballast will be greatly improved.

Cinders as ballast find their greatest use in the following situations: On branch lines with a light traffic; on sidings and yard tracks near point of production; in wet, spongy places in cuts and on bad fills; as sub-ballast on new work where dumps are settling; at places where the track heaves from frost; in retarding vegetable growth.

Anthracite coal cinders make a better ballast than soft coal cinders, and there is considerable difference in the quality of cinders produced from different kinds of soft coal.

When the cost of loading cinders from the ash pit and laying down on the side of the track is charged against the ballast, it will not be found economical to haul cinders more than twenty miles, and consequently they are used mostly in the vicinity of division points.

The remarkable capacity of cinder ballast for absorbing water renders it more valuable than either stone or gravel in maintaining a dry track.

During a heavy rain the water will seldom penetrate more than two inches from the top and dries out rapidly when exposed to the sun.

Cinder ballast has the disadvantage of being dusty in dry weather, and the sulphur it contains is generally conceded to have an injurious

effect, tending to shorten both the life of the tie and the rail. The latter may very largely be obviated by so forming the ballast section that the bottom of the rail will be from two to three inches above the cinder.

It is claimed, too, that the adhesion between the locomotive driving wheels and the rails is appreciably less on cinder ballast and that consequently this material should not be used on heavy grade.

Cinders are also objectionable where track circuits, in connection with crossing bells, signals, etc., are maintained, on account of the readiness with which short circuits are formed.

CHATS.

Chats are practically screenings, and their value as ballast is dependent on their hardness and size. There is considerable variety in these respects, though practically all of the product of the lead and zinc mines of Southwestern Missouri and Southeastern Kansas is suitable for ballast purposes. Tailings from hand jigs for separating lead and zinc ores from the rock formerly ran in size from one inch to one and one-half or two inches in greatest dimension, practically the same as crushed rock under 1½-inch specifications. This was much sought after by roads entering the mining district and gave results practically the same as crushed rock of same size. With the introduction of power machinery the ore-bearing rock was crushed much finer than for hand jigs and with the rise in price of zinc and lead still finer crushing was practiced. It gives a fair idea of the size to say it is about the same as shelled corn, or will pass a screen with half-inch mesh or possibly a little smaller.

Chats are elastic; not dusty except at high speeds, and then only slightly; cheap to load, unload and handle under ties; hold well in both line and surface and particularly check growth of vegetation. They practically prevent the latter entirely. They wash more easily than stone or gravel of larger size; settle somewhat when first put in track and require a second surfacing to hold well; do not drain so well as larger crushed rock, and consequently churn when soil gets mixed with them or there is an insufficient thickness under the tie. To hold line on curves there should be a wider shoulder than with crushed rock, preferably 12 inches. Minimum thickness under tie for good results, 8 inches. The cost may be as low as 25 cents per yard in track, being greater as the distance from source of supply increases. They are easily and cheaply loaded by hand. At the larger piles the steam shovel is economical.

CHERT.

(Extract from letter addressed to R. Montfort, Chief Engineer, Louisville & Nashville Railroad, by T. D. Harrison, Assistant Engineer.)

Chert is almost all pure silica and in this district (Birmingham, Ala.) is of three kinds—white, yellow, and pink—all of which are used for building roads.

White chert is a clean chert and is not much account for building roads.

Yellow chert and pink chert contain more or less clay and consequently pack and make an excellent road.

Some of the chert in this district is found in strata, while that which is worked is principally drift chert, and found in large beds, broken up to a great extent, and can be worked easily by blasting from a large face.

The following is copied from James D. Dana's Manual of Mineralogy and Petrography:

CHERT.—An impure flint or hornstone, occurring in beds or nodules in some stratified rocks. Often resembles felsyte, but is infusible. Colors, various. Sometimes oolitic. Kinds containing iron oxide graduate into jasper and clay-ironstone; and others, occurring as layers or nodules in limestone, are whitish, owing to the limestone material they contain. Chert sometimes contains cavities which are lined with chalcidony or agate, or with quartz crystals, making what are called geodes.

FLINT, HORNSTONE, CHERT.—Massive, compact silica, of dark shades of smoky gray, brown, or even black, feebly translucent, breaking with sharp, cutting edges and a conchoidal surface.

Chert is an impure hornstone. (Page 469.)

Chert is similar in action under track to gravel containing clay, but on account of the stone being sharp, where gravel is rounded off, the chert holds better than the gravel.

SLAG.

Slag which is most uniform in size and heaviest in weight is most valuable for ballast purposes. These qualities depend largely on how it is made. Sometimes the slag is drawn from the furnace and run directly into long depressions or shallow ditches. This gives a number of slabs of half round section, ten or twelve inches wide, sometimes called "hog wallow" slag, from the form of the depressions. This, of course, must be broken up with hammers or crushers before it is used. The large pieces may be used at the foot of the slope of the ballast to hold the smaller pieces in place, but are a decided disadvantage when they get under the tie. They must then be broken up with sledge before track can be surfaced.

The product is much more satisfactory where the slag is carried in a hot pot from the furnace and poured upon a dump. The dump, by reason of continued additions, may become almost a mountain, and many very large ones may be seen in the iron district of Alabama. While it might seem that this dump would be as solid as rock, having solidified from a melted state, this is not the fact. The application of a hot upper layer upon a cold one beneath appears to crack the latter in all directions, much as cold glass is cracked by hot water. The result is that the mass may, although with difficulty, be worked with pick and shovel. The usual way of loading is by steam shovel. A little powder is a decided help toward loosening and breaking the mass, whether for hand or shovel loading.

When the slag contains an excess of free lime or has been formed in thick layers, a large portion will be found to be spongy. This is likely to become pulverized under the track, cementing together, becoming difficult to work and churning in wet weather. The vitreous or glassy slag often breaks into pieces nearly cubical in form and of remarkable uniformity in size, the pieces being about one inch in each dimension. A slag dump will not run uniformly to one size or kind, however, and the run of the pile must be taken as it comes. There is a great deal of dif-

ference in the slag from different furnaces. To some extent it may be said that those that make the most perfect separation of iron from ore and flux make best slag for ballast. It is certain that any scattered masses of metallic iron are objectionable.

Slag ballast track usually requires a lift of two or three inches, and to be surfaced out of face at intervals of two to six years, depending on the quality of the material and the traffic it sustains.

Slag is cheaper in first cost than broken stone, but the cost of maintenance is somewhat higher and the effect upon the ties is said to be detrimental because of the chemical action of the slag.

The cost of renewing ties in slag ballast varies from nine to fifteen cents, depending upon conditions.

SHELLS.

Certain kinds of shells, in localities where they are plentiful, have been used for ballast. Your Committee has as yet obtained no information relating to their use and would be glad to hear from any of the members who know anything about them.

Some tables of cost of broken stone, gravel, slag and burnt clay are submitted. They are not intended as complete statements, but rather as a basis for discussion, with the hope that further figures will be supplied by the members. In addition to cost f. o. b. cars, the Committee hopes to get figures on hauling, unloading and placing under track. A fair comparison of relative value can not be made until we have total cost under track and also annual cost of maintenance after being put in place.

COST STATEMENT.

Tabulated Statement showing the cost of Stone, Gravel, Slag, Burnt Clay or Burnt Shale on a few typical Railways in the United States.

Railroads.	Stone, cu. yd.	Gravel, cu. yd.	Slag, cu. yd.	Burnt Clay or Shale, cu. yd.
Bangor & Aroostook	.....	0.25-30	.....	.....
C., B. & Q.	0.65	2	.....	.....
C. I. & L. Ry	0.44	10	.....	.....
C., M. & St. P.	0.45	2.5	.....	40
C. O. & G.	0.80	35	.....	55
Cumb. Valley	0.45	.....	.....	.....
Ill. Central	50-60	12-18	0.20-25	.....
K. C., Ft. S. & M.	50-60	25-35	15	.....
Long Island	55	12	12	.....
L. & N.	40-45	10	.....	.....
Mich. Central	.....	6.8	.....	.....
N. C. & St. L.	50	10-15	12.5	.....
N. & Sou.	.....	1	.....	.....
N. & W.	50-60	12	15	.....
Pennsylvania	$1.25 in track.	.....	.....	.....
Pa. Lines, Chicago Div.	41.6	3-15	10	.....
Pa. Lines, Pitts. Div.	54	2	.....	.....
P. & N. W.	51	.....	.....	.....
Seaboard Air Line	50-60	16-20	.....	.....
St. L. & S. F.	55	21	.....	.....
Southern	45-55	10-15	12-15	.....
Texas Midland	67	12	.....	52
Wisconsin Central	25-55	5-10	.....	.....

Note—The prices given are for the material f. o. b. cars at quarry or pit, and not in track, except where noted.

COST OF BURNT CLAY BALLAST.

	H. & St. Jo 3d Fork 1900	Burlington Biglow Pit	Burlington So. Isham 1896	Burlington Chariton Pit	Burlington Rushville Cutoff	Texas Midland Delta Co.	Wabash	A. T. & S. F.	St. L. K. & N. Ft. Madison, Ia. 1898	K. C. St. J. & C. B. Phelps Mo. '98	St. L. K. & N. Seeberger, Mo. 1899	H. & St. J. La Clede 1899	Texas Midland, Ellis County
Land	.....	.....	.....	.....	.....	0.0133	.....	.....	.....	.....	.....	.....	0.0008
Burning	0.1685	.....	.....	0.2000	0.250	0.2000	0.240	0.2000	0.1770	0.1770	0.1770	0.1635	0.2239
Coal Fuel	0.2046	.....	.....	0.1290	0.307	0.1605	0.350	0.1000	0.2806	0.4807	0.2436	0.2167	0.1623
Wood Fuel	0.0117	.....	.....	0.0035	.....	0.0008		.....	0.0021	0.0284	0.0076	0.0066	0.0042
Transportation	.....	.....	.....	.....	.....	.....	.....	0.140†	.....	.....	.....	.....	.....
Engineering	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.00002
Temporary tracks	0.0826	.....	.....	0.0191	.....	.....	.....	.....	0.0163	0.0185	0.0286	0.0260	0.0051
Incidentals	.....	.....	.....	.....	0.032	.....	.....	.....	.....	.....	.....	.....	0.0001
Total	0.4156	.....	.....	0.3516	0.589	0.3905	.....	.....	.....	0.7046	0.4568	0.4128	0.4097
No. of tons	54,283	.....	.....	.....	.....	83,180	.....	.....	57,444	33,135	51,178	158,470	83,180
Yds. per ton coal	3.5	.....	.....	4.29	.....	.....	.....	.....	3.7	2.10	2.58	3.37	.....
Loading	.....	0.145	0.0793	.....	0.079	0.3608*	.....	0.058	0.4760	.....	.....	.....	.....
Unloading													
Putting in track	.....	0.093	0.1239	.....	0.124	.....	.....	0.140	.....	.....	.....	.....	0.3608‡
Transportation	.....	.....	.....	.....	0.145*	.....	.....	.....	.....	.....	.....	.....	.....
Preparing rock	.....	0.057	.....	.....	0.080	0.3542	.....	0.097	.....	.....	.....	.....	0.3542
	.....	0.295	.....	.....	.....	.....	.....	0.735	.....	.....	.....	.....	.....

* Includes unloading. † Includes putting in track. ‡ 250 miles on fuel; 50 miles on ballast.

The data from which these tables are compiled are more or less incomplete, and while some items of cost can be compared, the total cost is not readily comparable.

Since broken stone is the only ballast material whose qualities can be regulated in process of manufacture, it seems that no arguments need be submitted except as regards that material. Burnt clay, it is true, varies according to methods used in producing it, but there is no diversity of opinion as to the product aimed at, which is a hard, durable ballast. The size of the particles is regulated by the nature of the gumbo itself, and the question to be settled in the cases of the different soils is what quantity of coal and what method of treatment will give the desired result with greatest certainty. With chats, chert, cinders, gravel, slag or sand, it is a question of what is available, or, if more than one is available, which is the fittest?

With broken stone, the question of what kind of stone to use may be one of availability, but the size to which the stone shall be crushed and the size of the particles to be screened out are matters upon which there is room for argument. Advocates of the larger sizes of stone contend that they give larger spaces between the stones, thus affording better drainage; also that the spaces are longer in filling up with dirt, thus giving longer life to the ballast and reducing cost of cleaning where this is practiced. The larger sizes of crushed rock also cost less to produce. The advocates of the smaller sizes admit the greater first cost, but contend that the labor of surfacing is less to begin with and the cost of maintenance is also less thereafter. With smaller rock, joints can be picked up and put in shape, which could not be handled with larger rock except by making a uniform raise of two inches or more and a general surface. It is claimed that the filling of the ballast with dirt is too slow a process to offset the advantages of light surfacing afforded by the finer sizes. Advocates of a minimum size of screen hole of ¾-inch contend that, with smaller holes in wet weather the fine screenings stick together and do not go through the holes at all, thus making dirty ballast to begin with. So far as the Committee knows, it has not been shown that there is any advantage in retaining particles less than ¾-inch in size unless it be in the matter of cost.

CONCLUSIONS.

While there is great variation in the qualities of the different natural materials for ballast, the choice of these qualities is not usually left to the engineer, but has been made already by nature, and all that is left to decide is what is most available or most expedient. This each one must decide for himself in the light of his own circumstances. The question of finance may be a ruling consideration or there may be but one thing to be had, and he must take that or nothing.

*In the case of crushed rock, however, there is a choice, and it is the conclusion of the Committee, in the light of arguments presented, that stone ballast made from hard, durable stone, broken in sizes from ¾-inch to 1½ inches, having a depth under tie of 12 inches, resting on a firm,

*See amendments, page 495.

well-drained roadbed, will best meet the requirements of roads with heavy traffic, large engines and fast service.

Respectfully submitted,

J. V. HANNA, *Chairman;* Assistant Chief Engineer, St. Louis & San Francisco Railroad, St. Louis, Mo.

C. A. PAQUETTE, *Vice-Chairman;* Superintendent, Cleveland, Cincinnati, Chicago & St. Louis Railway, Indianapolis, Ind.

W. W. COLPITTS, Assistant Chief Engineer, Kansas City, Mexico & Orient Railway, Kansas City, Mo.

F. T. HATCH, Superintendent Vandalia Line, Terre Haute, Ind.

E. HOLBROOK, Chief Engineer, Missouri, Oklahoma & Kansas City Railroad, Oklahoma City, O. T.

J. O. OSGOOD, Chief Engineer, Central Railroad of New Jersey, Jersey City, N. J.

J. G. SULLIVAN, Division Engineer, Canadian Pacific Railway, Winnipeg, Manitoba.

G. M. WALKER, JR., Assistant Engineer, Kansas City Belt Railway, Kansas City, Mo.

Committee.

AMENDMENTS.

BALLAST.—Selected material placed on the roadbed for the purpose of holding the track in line and surface.

CHERT.—An impure flint or hornstone, occurring in beds.

GUMBO.—A term commonly used for a peculiarly tenacious clay, containing no sand.

ROADBED.—(Strike out definition.)

SPECIFICATIONS FOR STONE BALLAST.—(b) It should be hard enough to prevent pulverizing under the treatment to which it is subjected.

(2) SIZE.—(a) The maximum size of ballast shall not exceed pieces that can pass through a 2-inch ring.

(b) The minimum size shall not pass through a screen of ¾-inch holes.

CONCLUSION No. 2.—In the case of crushed rock, however, there is a choice, and it is the conclusion of the Committee, in the light of arguments presented, that stone ballast be made from hard durable stone, broken in sizes from ¾-inch to 2 inches.

DISCUSSION.

MR. WALTER G. BERG (Lehigh Valley—by letter):—Under the good characteristics of engine cinders it might be noted that they tend to keep down weeds. All the conclusions from No. 1 to No. 8 are correct. The report is concise. The use of screenings from stone crushers for ballasting inferior tracks is not referred to in the report. A number of railroads have experimented with screenings for some years and it might be desirable for the Committee to ascertain and report on the results thus far obtained. Another question is whether it would be possible for the Committee to define maximum axle loads and speed limits for the various classes of ballast, such as cinders, burnt clay and gravel, thereby indicating the traffic conditions under which a company would be warranted in spending more money for a higher grade ballast.

MR. W. C. CUSHING (Pennsylvania Lines—by letter):—Referring to the specifications for stone ballast in this report, I have obtained some facts from the manufacturers of stone ballast which have an important bearing on the cost of the product under the proposed specifications which I think should be laid before the members of the Association before their sanction is given to them.

A common specification for making limestone ballast at the present time is that it shall pass through a 2½-inch ring and be caught on a ¾-inch screen. Actual records show that this specification makes about from 20 to 25 per cent. screenings, with fairly clean stone, or one car out of every four is a car of screenings.

It is known at the present time that in the winter and spring months, when the weather is very wet and the temperature at freezing, a ¾-inch screen is rather small, but under no circumstances should less than ⅝ of an inch be used.

Competent quarrymen estimate that if a stone ballast is required to be passed through a 1¾-inch ring and be caught on a ¼-inch screen the screenings would be reduced from 12 to 15 per cent. and the output would be reduced from 35 to 40 per cent., and the cost of production would be increased from 20 to 25 per cent. Furthermore, in damp weather not 5 per cent. of the screenings will pass through a ¼-inch screen, resulting in a very dirty ballast.

While I am an advocate of as fine a ballast as possible, it should be borne in mind when making specifications that the practicability of making fine ballast in limestone must be carefully considered. I think, therefore, the Committee specification as proposed is too fine for limestone ballast. Those who have had experience with trap-rock ballast, or other stone ballast equally as hard and tough, should give their experience likewise.

As to any saving in cost in handling the smaller sizes of broken stone, I do not believe that there is any appreciable saving, although I have no exact figures on the subject. In fact, I am inclined to think it will be a little more costly, as the waste, owing to the finer sizes, will be greater as the track is worked over and cleaned out from time to time.

That is one of the advantages of the coarser sizes, viz.: that it is more easily cleaned and it takes a longer time to become pulverized under the tamping pick than the smaller sizes would.

The following table has been furnished the Committee through courtesy of Mr. Jos. T. Richards, Chief Engineer M. W., P. R. R.:

BALTIMORE & POTOMAC R. R.—Record of Experimental Test of three different sizes of broken stone ballast—Aug., 1899-Oct., 1903 (both inclusive).

	Size of Stone Ballast.		
	3-4 in.	1 1-2 in.	2 1-2 in.
Double track ballasted (ft)	5280	5211	5280
" " " (miles)	1.0	0.987	1.0
Stone ballast used (cars)	228	171	198
" " " (tons)	6200 9-20	4651 16-20	4947 37-40
Cars of stone per mile of double track	228	173	198
Tons " " " "	6200	4713	4948
Linear feet of double track covered by 1 car of stone	23.1	30.5	26.7
Linear feet of double track covered by 1 ton of stone	.85	1.12	1.07
Average depth of ballast under ties	7 1-4 in.	6 1-2 in.	6 3-4 in.
Total first cost of ballast, freight unloading, putting in tracks, lining, surfacing, etc	$7911.60	$5633.51	$5263.92
Average cost per ft. of double track	$1.50	$1.08	0.997
" " " mile of double track.	$7911.60	$5708.10	$5263.92
Cost of ballast per ton at quarry	$0.60 to 0.70	$0.60 to 0.68	$0.58 to 0.69
Average cost of maintenance for period of 51 months	$94.66	$84.94	$82.13

Mr. C. H. Byers (Kansas City Southern—by letter):—While the crushing of stone so as to pass a 1½-inch ring would increase the cost, it is my opinion that the saving in cost of putting same in track will offset the additional first cost, even though the first cost was increased 20 per cent. The experience on this line is that fine material like gravel and chats can be put in track for 50 to 60 per cent. less labor than 2½ in. stone. Chats costs us 15c. on car, 3.5c. for train service and 18.5c. for labor unloading, preparing track and putting ballast in track, or a total of 37c. in track. Chert is heavily blasted so as to pulverize it as much as possible; it is then loaded with steam shovel and unloaded with Lidgerwood unloader and plow, and costs us a total of 54c. in track. Stone crushed so as to pass 2½ in. ring costs 50c. on car and 55c. to unload and place, or total of $1.05 in track.

While stone crushed so as to pass a 1½ in. ring could not be put in as cheap as chats, it is evident that it would materially reduce the labor of placing in track and subsequent maintenance.

The best ballast material we have is chert, which maintains better line and surface than either chats or broken stone, and at much less original cost than broken stone, and while it costs more than chats, its durability and the fact that it maintains track in much better line and surface more than offset the increased price.

Mr. J. V. Hanna (St. Louis & San Francisco):—This, I believe, is the first time that we have ever gotten the report before the convention in the shape outlined by instruction of the Board of Direction. A report was made a year ago and gotten out in pamphlet form, but was not considered by the convention.

You will see by the summary that the first conclusions submitted by this Committee were in the 1902 report, and related principally to cross-sections. The Committee has done nothing further along that line. We have made some sections, but have not gotten them in shape for presentation. When we do, we shall, of course, follow the recommendations as they are adopted by the convention. The Committee regards this report, in its present shape, largely as a progress report, and would be very glad to have discussion on what we have; also some indication of what the Association thinks is the proper line to follow hereafter. The President makes a suggestion which is in line with the Committee's desire. We would like to have the definitions and specifications for stone ballast, and the conclusions, such as we have presented, considered in detail by the convention.

The President:—Gentlemen, you have heard the statement of the chairman. What action do you wish to take on the report?

Mr. W. M. Camp (Railway and Engineering Review):—I move that we take up the definitions, specifications and conclusions in detail.

(The motion carried.)

The Secretary:—"Ballast.—Selected material placed on the roadbed for the purpose of holding the ties, which are embedded in it, in line and surface."

Mr. Camp:—I have found a definition, somewhere in this report, in looking it over, which seemed to cover that term more broadly. There is no mention of drainage in this definition. Can the chairman of the Committee indicate where that reference to drainage is?

Mr. Hanna:—It is under the heading "Analytical." Drainage is mentioned as the most important single requisite for economical maintenance.

Mr. Camp:—I move that the requirements of ballast, as expressed under the heading "Analytical," on pages 31 and 32, be included in the definition.

The President:—I am afraid that would be quite a long definition. Is the motion seconded?

Mr. G. A. Mountain (Canada Atlantic):—I will second that, not that I go as far as the mover. My idea is that a mention of drainage should be put in, as well as the purpose of keeping the road in surface. Whether all under the heading "Analytical" should go in is a question.

The President:—We would be glad to have the gentleman state the verbiage he would suggest.

Mr. Mountain:—As I seconded Mr. Camp's motion, I would have to agree to the whole of it.

Mr. Camp:—If my views are not supported, I will withdraw part of the motion, and suggest that the definition be made to cover drainage and the distribution of the load over the roadbed. These are certainly

two important points. I would move to insert at the end of the clause, 'to afford drainage of the track and to distribute the weight on the ties over the roadbed."

Mr. Hanna:—The object of ballasting and all this work we do on the track, is to keep it in line and surface, and drainage contributes to that; the distribution of the load over the roadbed contributes to it, and we do not think it is necessary in giving a definition to go into all of that detail. I believe we really would not care for the drainage, or distribution, or any of those things, except as they ultimately affect the line or the surface of the track. The definition, as it stands, really seems to cover the ground about as completely as we can without making it too long.

Mr. W. F. Tye (Canadian Pacific):—I think the Committee's definition is good, except that I think that they mean to hold the track in line and surface, instead of the ties.

Mr. Hanna:—That is true; it is to hold the track in line and surface, but it is the material in which the ties are embedded that holds the line and surface. We might possibly say, "Selected material placed on the roadbed for the purpose of holding the track in line and surface." If that is what is desired, we will accept it.

The President:—The question is on the proposed addition moved by Mr. Camp.

Mr. D. MacPherson (Canadian Pacific):—I think the Committee's definition is better than the proposed amendment. If the ballast holds the ties in line and surface, it will hold the track, provided the ties are good. If the ties are soft, they might allow the track to get out of line without any fault of the ballast. If the ties are held in line and surface, that fulfills the purpose of the ballast.

The President:—The ties are not generally in line; they are in surface; it is the track you want to keep in line and surface, both.

(The motion was lost.)

Mr. H. G. Kelley (Minneapolis & St. Louis):—Will not the gentleman who proposed to substitute the word "track" for "ties" make a motion to that effect?

Mr. Hanna:—The Committee will accept that.

The Secretary:—"Broken or Crushed Stone.—Stone broken by artificial means into small fragments of specified sizes."

(Adopted.)

The Secretary:—"Burnt Clay.—A clay or gumbo which has been burned into material for ballast."

(Adopted.)

The Secretary:—"Chats.—Tailings from mills in which zinc and lead ore are separated from the rock in which they occur."

(Adopted.)

The Secretary:—"Chert.—An impure flint or hornstone, occurring in beds or nodules in some stratified rock."

The President:—I wish to take exception to that, as I am somewhat familiar with the use of chert, and the definition tends to convey the idea

that the chert occurs in stratified beds. The fact is that it is the flinty residue that comes from the stratified beds after their disintegration, and I think the definition should be modified, as the chert is found in the form of drift, and not in stratified beds.

Mr. A. S. Baldwin (Illinois Central):—I think it would be well to call attention to the fact that chert is disintegrated material. There is nothing in the definition which calls attention to it. It is not disintegration that can be handled with shovels and picks.

Mr. Hanna:—I do not understand that any disintegration has taken place in the chert we find in the beds, and I also fail to see that the definition carries the impression that the beds are stratified. The second part of the definition is "nodules in some stratified rocks," and perhaps that could be left out, as it is a geological definition. Chert occurs that way, but the chert we get for ballast does not occur that way, and if we omitted that we might get rid of the idea that there was any stratification in the beds.

Mr. Baldwin:—Take the statement on page 37, in connection with the report of the Louisville & Nashville Railroad: "Chert is almost all pure silica in this district (Birmingham, Ala.), and is of three kinds—white, yellow and pink—all of which are used for building roads." That is an important feature of chert. It is natural ballast, so that it can be shoveled and packed into shape without any previous crushing. I think it would be well to have the definition so worded as to bring that out.

Mr. Hanna:—It would be difficult to do that without making the definition too long. The Committee would change the definition to read: "An impure flint or hornstone, occurring in beds." I think that is as much as we should put in the definition.

The President:—The Committee is willing to curtail the definition as just stated. The trouble seems to come from the fact that they have taken the definition from the geological standpoint instead of the standpoint of the man who uses it for ballast. On page 37 it is stated to be found in large beds, broken up to a great extent. The fact is, you rarely find it in chunks larger than that pitcher, and a slight blow will break up the chunks.

The Secretary:—"Cinders.—The residue from the fuel used in locomotives and other furnaces."

(Adopted.)

The Secretary:—"Gravel.—Small, worn fragments of rock, coarser than sand, occurring in natural deposits."

(Adopted.)

The Secretary:—"Gumbo.—Local name for a peculiarly tenacious clay, containing no sand."

Mr. W. McNab (Grand Trunk):—As there is nothing in this definition to qualify the extent of this localism, so to speak, in name, I move that the words "local name" be eliminated and the words "a term commonly used" be substituted.

Mr. Hanna:—The Committee accepts that change.

The Secretary:—"Roadbed.—The graded surface on which the ballast is placed."

Mr. Mountain:—This is a definition that should be in the report of the Roadway Committee. Does that come under ballast?

The President:—The two committees ought to agree, but both have to use it occasionally. I will ask the chairman of the Roadway Committee if that conflicts with his definition of roadbed?

Mr. McNab:—Not altogether.. We have in the Roadway report the following: "Roadbed.—The surface upon which a track is laid." The expression "track," in that definition, refers to the rails, ties and appurtenances and the ballast which holds it. When this matter came up first, I was going to suggest that we get together and harmonize the definitions of all words which have been dealt with by different committees. There are several such words in the Track report. If it would be in order, I would suggest that the consideration of the definition of "roadbed" be deferred until the Roadway Committee's report comes up.

The President:—It is in order; and the chair thinks that the definition of that word by this Committee is out of order. That is a matter that applies to the Roadway Committee.

Mr. Hanna:—The Committee accepts that ruling.

The President:—Strike out the definition of "roadbed."

The Secretary:—"Sand.—Any hard, granular, comminuted rock material, finer than gravel and coarser than dust."

The President:—This Committee has a right to define sand as applied to its work; so has the Masonry Committee a right to define sand as applied to its work. They are used for different purposes.

Mr. MacPherson:—Can we not get some easier word than "comminuted;" it is not an ordinary word.

Mr. Hanna:—Nothing better occurred to the Committee.

(The definition was adopted.)

The Secretary:—"Slag.—The waste product, in a more or less vitrified form, of furnaces for reduction of ore. Usually the product of a blast furnace."

(Adopted.)

The President:—The definitions as submitted have been approved with certain changes. Has anyone any suggestions? If not, we will proceed to the specifications on page 33.

The Secretary:—"Specifications for Stone Ballast.—Quality (a). Stone should be durable enough to resist the disintegrating influences of the climate where it is used."

(Adopted.)

The Secretary:—"(b) It should be hard enough to prevent pulverizing under the class of traffic to which it is subjected."

Mr. Baldwin:—It is not the traffic that pulverizes ballast; it is the tamping. If the tamping is done all right, the ballast is all right so far as the traffic is concerned. I suggest that the section read, "It should be hard enough to prevent pulverizing when tamped."

Mr. Hanna:—I believe it would be better to say, "It should be hard enough to prevent pulverizing under the treatment to which it is subjected."

Mr. Baldwin:—That is all right.

Mr. MacPherson:—Would it not be better to say "excessive pulverizing?" As a matter of fact, does not any ballast pulverize under this treatment, to a certain extent? It is therefore useless to ask for the impossible in specifications.

The President:—The ideal ballast would not pulverize, and the ideal is what we are seeking.

Mr. MacPherson:—Can we get such a ballast?

The President:—We can not get a cattle-guard that will turn cattle, and yet we put in the specifications that it should do so.

(The change as suggested by Mr. Hanna was adopted.)

The Secretary:—"(c) It should break in angular pieces when crushed."

Mr. F. S. Stevens (Philadelphia & Reading):—I agree with the arguments presented by the Committee as to the advantage of using small size stone. But we should bear in mind that small size stone fills rapidly, whereby the drainage is impaired or entirely destroyed. We should also bear in mind that small size screens clog rapidly, and that we get a very much larger proportion of the screenings in the ballast by using small size screens than we care for. I think, therefore, that the size recommended by the Committee should be slightly increased, that we may avoid the difficulties from the small size stones without incurring the trouble we would meet by getting the size too large. I ask if the Committee would be willing to change its recommendations to 2-inch and 1-inch, respectively, to overcome these troubles. I would be pleased to present a motion that the size of a circular opening through which the stone must pass, recommended by the Committee as 1¾ inches, shall be increased to 2 inches, and that the diameter of the ring through which the stone shall not pass shall be increased from ¾-inch to 1 inch, for the reasons I have named.

Mr. Hanna:—I call attention to one thing. In the last part of clause (a) of the second paragraph, the Committee says that a ring of 1½-inch diameter is preferred as a maximum measure of size. I understand that Mr. Stevens wants to leave that out and say that the maximum size of stone will pass through a 2-inch ring.

Mr. Stevens:—I would add that I quite agree with the Committee on that. I prefer 1½-inch stone, but you can not get 1½-inch stone unless you get a considerable amount of stone that is larger than that. The main object to be gained is to get the most of 1½-inch stone that is possible. To do that we must not set the crusher too fine, nor must we attempt to screen it too fine. If we limit the size to 2 inches as the maximum and 1-inch for the minimum, we will get as nearly as may be the 1½-inch size which the Committee recommends, and which I think we all agree is desirable. It is only in the interest of securing what we want that this motion is made.

Mr. W. C. Cushing (Pennsylvania Lines):—I have already expressed my views on page 41 of the Bulletin, but in the later pamphlet which has been issued there is some information in regard to the experiences with different sizes of ballast given by the Pennsylvania Railroad, and

before making any further remarks I would like to make two corrections in that report. The report says it was for the Baltimore & Ohio Railroad. The "Ohio" should be stricken out and the word "Potomac" should be put in its place. That is the lower end of the Philadelphia, Baltimore & Washington main line between Philadelphia and Washington. In place of my name appearing there, I would like to have the name of Jos. T. Richards, Chief Engineer Maintenance of Way, Pennsylvania Railroad, substituted, as I obtained that information from him. It is not from my personal experience, but from his.

With the trap rock which can be obtained in the East, probably a fairly fine ballast is desirable, but it is clearly indicated in this test, which extended over four years, that it is the coarser, and if the matter of renewals had entered into this report, which it has not up to the present time, it would show against the finer ballast much more definitely than it is in the present report, because there is a considerable portion of the ballast lost in forking over for the tie renewals or tamping through the season. With a limestone ballast the size should be greater, and we on this side of the Alleghany Mountains are almost entirely restricted to the use of limestone ballast, except in isolated localities. Nevertheless, I am rather in favor of setting the limit a little bit higher than Mr. Stevens has given it, so far as our present knowledge goes. I would like to see the ballast as fine as possible, but I do not want to get it too fine, so that it will become rather excessive in cost. A 2-inch ring will make what is called 1½ or 1¾-inch ballast, and I think the limit of the ring should be raised so as to make the ballast about 2-inch ballast.. That would require the superior limit to be a 2¼ to 2½-inch ring. The lower limit recommended by the Committee I think is about right—a ¾-inch screen—and I am quite in favor of that. I therefore wanted to express these views before the vote was taken on Mr. Stevens' question, so as to call the attention of the members to it. I think it is a very important matter indeed, and the fuller the information we can obtain on it the better.

The President:—We would like to hear from everybody that knows anything about this.

Mr. J. A. Atwood (Pittsburg & Lake Erie):—I agree with Mr. Cushing and think that the size should be raised to 2½ inches. A ballast which runs the ordinary size of 2 inches is very satisfactory ballast, gives good drainage, and I think a motion to that effect should be carried.

The President:—Anything further? As to the size of the holes for the ballast?

Mr. Hanna:—I would like to suggest that possibly this coarser ballast is entirely suitable or best for a road having heavy traffic, such as some of the roads have that can get crushed rock, but possibly a little finer ballast is cheaper to maintain under the lighter traffic. Our experience with a fine crushed rock approaching 1½ inches has been very satisfactory. The difficulty has been that we have not kept accurate records of the cost. I think, by the way, that we all need that kind of thing

badly. That is the ultimate test after all—what it costs. The Committee would like to have that as throwing light on this question.

Mr. H. M. Waite (Cincinnati, New Orleans & Texas Pacific):—I think, as outlined by Mr. Stevens and Mr. Cushing, it has been our experience when you screw down your crusher to such a fine point as to limit yourself to 1¼-inch rock, you get clearly too much screening, and the price immediately goes up on the output of the crusher.

The President:—I would like to hear from Mr. McGuigan on the subject.

Mr. F. H. McGuigan (Grand Trunk):—I have not heard anything from the other gentlemen, but I am in favor of a very small screen.

The President:—Are you ready for the question on the amendment of Mr. Stevens? Mr. Stevens has moved to amend paragraph 2 on page 33 of the specifications, substituting 2 inches for 1¾ inches, in the second line of the paragraph, striking out the words "but a ring of 1½-inch diameter is preferred as the maximum measure of size," and substitute "1 inch" for ¾-inch in section (b) of that paragraph.

Mr. Atwood:—I would like to move an amendment to this amendment and substitute for 2 inches as the maximum size of the ring "2½ inches," and that we strike out the portion of the amendment that refers to the striking out of the ¾-inch size.

The President:—An amendment to the amendment has been moved and seconded. That is a motion in lieu, is it not, Mr. Atwood? It takes the place of the other amendment?

Mr. Atwood:—Yes, sir.

Mr. Baldwin:—In stratified stone, some of it splits up into long slabs. With a ring 2 inches and an arrangement to carry the rejects of that into the crusher, I think you would get a very satisfactory ballast, even as high as 2¼ inches, but the majority of the crushing plants do not have an arrangement to carry the rejects back. I believe 2¼ inches would be about the proper limit.

The President:—The best way to settle this would be to take a vote on the maximum size of 2½ inches and a minimum size of 1-inch first.

Mr. H. T. Porter (Bessemer & Lake Erie):—I would add the words "passing through a 2½-inch ring in any direction," so that leaves the question to the manufacturer how he should do that.

Mr. Cushing:—It is best to add in the specifications that the slabs of which Mr. Baldwin speaks should be returned to the crusher or cracked on the car by a man stationed there. That is lacking in this specification, and there are many limestone countries where that has to be done.

The President:—The main question to be decided first is to arrive at the largest hole of screens. The largest size proposed is 2½ inches. All in favor of the 2½-inch size for the larger hole will say aye. The motion is lost. All in favor of the 2¼-inch will say aye. The motion is lost. All in favor of the 2-inch will say aye. The motion is carried. We will now take a vote on the minimum. All in favor of the ¾-inch size recommended by the Committee will say aye. The ¾-inch size

recommended by the Committee is adopted. Before we proceed with this matter we want to take a vote also on the 1-inch size. All in favor of the minimum size of 1-inch will rise.

Mr. J. G. Sullivan (Canadian Pacific):—The Committee wishes to change that so as to be in form to be put in the specification, by cutting out "it is recommended that," and cutting out "it is preferred" as the maximum measure of size, and also note (b), "it is recommended that." It will then read: "The maximum size of ballast shall not exceed pieces that can pass through a 2-inch ring." "The minimum size shall not pass through a screen of ¾-inch holes."

The President:—I think the convention will allow the Committee to make that change.

The Secretary:—"(3) Quantity in Track.—(a) It is recommended that the minimum thickness of six inches under the tie be considered as ballasted track, but that a minimum thickness of 8 inches under the tie is preferred. (b) The extreme maximum thickness of 18 inches under the tie is recommended, with an ordinary maximum of 12 inches. (c) The upper surface of the ballast should be level with the top of the ties. (d) The upper surface of the ballast should extend 9 inches beyond the ends of the ties. (e) The slope should not be steeper than 1½ to 1."

Mr. Hanna:—We would like to have the opinion of the convention whether it is a specification or a conclusion.

The President:—I think the discussion is proper and it is well to bring out your opinions.

Mr. Cushing:—Is that a proper specification for this Committee, in view of what was said about cross-ties yesterday?

The President:—It is hardly in proper form, but they are gradually revising it to make a specification as we go along.

Mr. Tye:—It seems to me the minimum thickness, 6 inches or 8 inches, is too small, especially in view of the decision of the convention as to the width of roadbed. I think three years ago they decided the roadbed should be 20 feet. If you take ballast of minimum thickness of 8 inches under the ties, it will leave about 3 feet of margin between the edge of the ballast and the edge of the roadbed, which would be rather ridiculous: either the roadbed would be too wide or the ballast too small. I understand that we are trying to get up specifications for an ideal road, and therefore the minimum should be at least 12 inches, and preferably more, with a roadbed 20 feet wide.

The President:—The gentleman evidently does not have to make out an Interstate Commerce report as to how much ballasted track he has.

Mr. Tye:—I would not like to say three feet outside of the ballast, because that would be a waste of materials in the roadbed.

The President:—I would like to hear from other members on the recommendation.

Mr. Baldwin:—We accepted some suggestions from the Committee on Ties. They were allowed to submit ties of different dimensions for different kinds of track. All railroads of any extent have different classes of roadbed, and I think we should have a recommendation of the

Committee as to different classes of track. Class A would be first-class in every respect; class B subsidiary lines, and class C branches. Then have proportions between the roadbed, the ballast and all the other appurtenances.

The President:—That brings up a question that has often been discussed, as to whether we are trying to arrive at the ideal or whether we are trying to adapt ourselves to conditions as they exist.

Mr. Cushing:—In trying to arrive at the ideal, the maximum limit should not be less than 18 inches. Some experiments or investigations were made some time ago by the German railroads for determining that very point, and it is found that with any less thickness than about 18 inches the ballast is entirely buried up in the roadbed and becomes a part of it in the course of time. With the 18-inch thickness and beyond the condition remains fairly good for a considerable period, but any such thickness as 6, 8 or 12 inches allows the condition I mentioned a short time ago to prevail, and it is crushed down and mixed in with the surface of the subway beneath.

The President:—Mr. McGuigan, will you give us your views on the thickness of the ballast under the ties?

Mr. McGuigan:—If the Committee is preparing this report to humbug the Interstate Commerce Commission, as the President has intimated, I think 6 inches might possibly do, but if we are prescribing a depth of ballast to sustain the heavy loads that most railroads are carrying to-day, I should say that less than 12 inches on a very good roadbed would not be good practice. I am satisfied that in many sections of this country you could not give a roadbed in its early stages worse treatment than to put only 6 inches of broken stone ballast on the track. If only 6 inches of rock is used, especially on many lines between the Mississippi and Missouri Rivers, the rock would very soon be forced down into the roadbed, making a well that will hold water and result in very bad track. The adoption of a specification for less than 12 inches of broken stone for an ideal roadbed would, in my opinion, be a mistake.

The President:—The Committee recommends that 6 inches thick be considered as ballasted track, 12 inches preferred.

Mr. Kelley:—The remarks of Mr. McGuigan I consider very timely. Anyone who has ever used rock on a new roadbed knows that it will disappear with rapidity in a wet season. If you had 6 inches of gravel under it you would get better results than with 6 inches of rock, where the gravel or the rock rested on the roadbed, because, with only 6 inches of supporting material under your ties, you get but a slight increase in bearing area. The rock, having a number of appertures, affords less bearing area than the gravel, with the result that the mud is squirted up through the rock and comes out above the top of the ties. So that I agree with Mr. McGuigan, and also that anything less than 12 inches under the ties for rock should not be considered ballasted track.

Mr. Tye:—I understand that that is not the recommendation of the Committee. The recommendation of the Committee is 8 inches preferred.

The President:—That is the latest recommendation of the Committee.

Mr. Kelley:—I will correct my remarks, and to make them clear I should say that the minimum should be 12 inches for rock.

Mr. Atwood:—I agree with Mr. Baldwin, and I do not think we will arrive at any definite conclusions as to the proper amounts of ballast to be used unless we specify two or three or more different classes of traffic, and I think it should be the duty of the Committee to prepare definite classes of track.

Mr. C. S. Churchill (Norfolk & Western):—I am a little at a loss to understand the whole of these specifications, because in no place in them, except this one, is thickness of ballast mentioned. I infer that this thickness of ballast refers to any kind, and is not limited especially to stone. I would ask the Committee's idea whether this thickness under items (a) and (b) refers only to stone, or is it applicable to gravel, slag, etc. If not applicable to the latter, then what is the thickness they would recommend?

Mr. Hanna:—It is possible we are using the wrong name in saying that this is a specification. It is a recommendation; but applied to stone ballast, the recommendation of the Committee is that 8 inches is the minimum depth of stone that should be considered ballasted track. I will say in connection with the fact that stone will work down into a green roadbed, of course that point is well taken; but it does not follow that you have to ballast your track with stone the first thing that you do. You may hold off your stone ballast until the roadbed is ready to take it, and then in that case 8 inches may be a minimum, and I think there are a good many roads that would be glad to get 8 inches of stone ballast and consider it ballasted track.

Mr. McGuigan:—I assume that a majority of the gentlemen present have more or less responsibility in connection with the cost of maintenance of track. That being the case, we should hesitate to adopt as a standard a ballast specification which we know will not enable us to maintain track in good condition under heavy traffic, and if we go on record as saying that 6 to 8 inches of broken stone will make a good track, we may find it very embarrassing in trying to explain our ability to do so after the money has been expended. The gentlemen who have had much experience with stone ballast know that, except upon a very good, well-seasoned roadbed, previously ballasted with broken stone, gravel or other good material, track can not be maintained in good condition with 6 or 8 inches of rock ballast; therefore I hope the Committee will keep in mind the fact that they are making standards that we may hereafter be compelled to work to, if this Association puts itself on record that a good track can be made and maintained with 1,400 or 1,500 cubic yards of broken stone per mile of track, as some roads claim to be doing. We have at the present time under consideration the question of ballasting with rock a considerable mileage of our track, therefore I am especially anxious that the recommendations of this Committee should favor a sufficient depth or quantity of ballast to insure good track: I hope they will not get down to 6 or 8 inches.

Mr. Baldwin:—I would like to ask Mr. McGuigan, if he were build-

ing a branch line for very light traffic, from which he did not expect to get a very large revenue, certainly not immediately, would he wish to put that up with 20 feet embankment and 32 feet cuts and 18 inches of ballast? You would not, of course. But at the same time you would want to build that branch so as to be the best of its kind. Now, I think the only way of getting around that feature is for the Committee to make a definite recommendation for different classes of track. If we have a branch, we want it to be a good branch, and we want the specifications for it to be all that they ought to be for the business that that branch is to do. If we are building a first-class line in every respect, we wish that line to be first-class, and we should certainly have as much as 18 inches of ballast on it, and I would move that these specifications be referred back. Is there a motion before the house?

The President:—On the adoption of the clause as recommended.

Mr. Baldwin:—I move as an amendment that these specifications be referred back to the Committee, with a request that definite specifications shall be made by the Committee for several different characters of track.

Mr. McGuigan:—Mr. Chairman, with your permission I shall say in reply to the gentleman that if I were building very light branch lines, I certainly would not make the embankment 20 feet wide, but on reasonably good material would make them 12 to 14 feet, in accordance with requirements, and would not use rock ballast if I could get anything cheaper that would hold the track.

Mr. Tye:—I do not think it is right to refer this back to the Committee, asking for specifications for different standards of ballasting. It has been repeatedly decided by the convention that we were making specifications for a first-class road. It has been repeatedly decided that the roadbed should be 20 feet wide. That means a first-class road, and I do not see why you should stick out for a high standard of roadbed and lower the standard for ballast. If we are making all specifications for a high-class road, why go to a lower standard on this particular thing?

Mr. Hanna:—I do not agree with the last speaker that we should confine ourselves entirely to ideals. We do not get much chance for ideals, and we will get more benefit out of the work of the Association if we get something that is applicable to the conditions under which we work every day. I think Mr. Baldwin's motion is in the right line. It would be a good thing for the Committee to draw specifications for the different characters of track, but I would like to have an expression from the convention as to the classes that we ought to cover.

Mr. Cushing:—I find it very difficult to talk to the Ballasting Committee on this question when it ought to be the Track Committee, but nevertheless I would like to say that this question has no place in the specification for stone ballast. It has nothing to do with the specification, and we are rather beating around the bush in discussing it under that head. If the Association desires to give an expression on the thickness of ballast, for this Committee or some other committee to work on, in connection with a standard cross-section of ballasted track, it is right and

proper, but it is not proper to refer this back to the Ballast Committee as a part of their specifications for stone ballast.

The President:—The gentleman's point is well taken. The quality of the ballast is what the Committee on Ballast should consider.

Mr. McGuigan:—Would it not have been proper for the chair to have ruled that as not a debatable topic?

The President:—It might have been proper, but it was printed in the Committee's report.

Mr. Hanna:—I would like to say just one word in defense of the Committee. On page 28 of Bulletin No. 46, referring to the report submitted in 1902, the recommendations of the Committee made at that time were adopted by the convention, and we supposed they were in line.

The President:—The gentleman is correct.

Mr. Cushing:—At the last convention I made a recommendation that these two committees, Track and Ballast, ought to be combined, and I still think so.

The President:—That is a matter that should come up in the business meeting.

Mr. Atwood:—I still think we are up against a proposition in deciding about these specifications. One year ago we adopted ballast from 8 to 12 inches. It shows we were trying to adopt a thickness of ballast that covered many conditions. I still think that we ought to refer this back to the Committee and have them present to us specifications for different characters of track, say characters A, B and C. I think three would be sufficient, and we can apply the specifications for different classes of track for the different classes of line that we want to build.

Mr. R. Trimble (Pennsylvania Lines):—I think that this specification of ballast should be treated along the same lines as other specifications. It is the material that you are probably going to buy from a contractor. He does not care whether you use 6, 8 or 12 inches under your tie. What he wants specifications for is to show what he has to furnish the railroad company. It seems to me the Committee possibly made a mistake by putting in the thickness of the ballast to be used under the ties, and if that part of the report is eliminated it will simplify the matter very much. I do not think it is fair to refer the specifications back to the Committee to bring in a report for different classes of track. I think specifications should be for material only.

The President:—The gentleman is unquestionably correct.

Mr. Baldwin:—We would still wish to get a recommendation from the Committee in regard to the thickness of ballast.

Mr. Hanna:—The Association put itself on record in 1902 by adopting the recommendations of the Committee at that time. I think it will have to reverse itself before it takes this out of the hands of this Committee.

Mr. Trimble:—Two years ago, when the matter was up, we were discussing the question of the thickness of ballast. Some of the men said if they had 6 inches of ballast under their ties they would be well satisfied; they had only two or three, and some probably did not have

any; the probability is two years from now some of them will not have any ballast under the ties.

Mr. R. C. Barnard (Cleveland, Akron & Columbus):—The gentleman has said the Association has put itself on record as to thickness of the ballast. If he argues that as a reason for not taking this out of the Committee's hands at the present time, we must also recognize that the Association has put itself on record as to different classes of track and roadbed. As Mr. Tye has stated, what this Association is working to is an ideal condition. If we could have the Committee get up specifications for A, B and C, I might be inclined to vote for it, but I think it would run through the alphabet two or three different times if it attempted to cover every classification that would come up. I think we should stick to our original purpose.

The President:—Mr. Trimble's position, that they should consider material only, is correct. The chair will call the attention of the convention to the outline of work of the Committee as originally planned by the Board, which reads as follows: "Ballasting—Material: Stone—size, quality: Gravel—cementing, loose, sandy. Burnt Clay—quality, method of burning, etc.; Slag, Cinder, and Burnt Shale; Chats—character; Earth; Dust prevention. Standard cross-sections (variations modified by material and other conditions). Cost: Material alone; loading; transportation; unloading; placing under tracks, surfacing and dressing. Methods: Handling material; keeping trace of cost and accounts. That constitutes ballasted track." That is the manner in which the work of this Committee has been laid out in the past, and in No. 5 the question is asked, "What constitutes ballasted track?" The question is, shall we adhere to that outline, or take the question of cross-sections out of the hands of the Ballasting Committee and put it in the hands of the Track Committee? It seems to me that is the first question we have got to determine—does the Committee deal only with the material for ballast?

Mr. Barnard:—Is a motion along that line in order?

The President:—The chair will entertain any motion that will get us out of the trouble.

Mr. Barnard:—In regard to referring this matter to another committee, I do not know whether Mr. Cushing put his remark in the form of a motion. If he did, I would like to recommend that the Committees on Track and Ballasting be combined.

The President:—The motion is that these two committees be combined, and the chair rules that that is a matter for the business session and not in order.

Mr. Cushing:—I move that clause No. 3 be stricken out of the specifications for stone ballast.

Mr. Baldwin:—I rise to a point of order. There is a motion before the house that the report be referred back to the Committee, and that the Committee shall be instructed in making its next report to consider several different characters of track. That motion was seconded and is now being argued.

The President:—The gentleman is correct.

Mr. Baldwin:—I would like to add to that: (A)—main lines with heavy traffic; (b) subsidiary lines with medium traffic; (c) branch lines with light traffic.

Mr. Kelley:—I rise for information. Is it in order for a motion to be made and received by the chair, to delegate to one committee the duties of another committee?

The President:—I think the motion is in order. I would rather have the decision of the convention on the subject. The Secretary will read the motion as it is now before the house.

The Secretary:—"Moved that specifications for stone ballast be referred back to the Committee, and that the specifications for ballast be made to cover three characters of track: (a) main lines with heavy traffic; (b) subsidiary lines with medium traffic; (c) branch lines with light traffic."

Mr. Tye:—I would like to point out, if this is carried, that the Committee on Roadway will be working under entirely different instructions. I understand our instructions were to prepare specifications for one class of road only, that is, first-class, high-grade, and that we did not in any way deal with anything else.

Mr. Trimble:—I would like to see Mr. Baldwin's motion voted down. I still do not think it is proper to refer this back. I do not believe it is covered in the proper way. I think I can possibly make a motion that will solve the difficulty.

Mr. Baldwin:—I would like to give the gentleman an opportunity to show his hand. I will accept a suitable amendment if Mr. Trimble makes one.

The President:—No amendment has been made yet.

Mr. Trimble:—What I proposed was this: That all of section 3 relating to quantity be eliminated from this specification, and that the matter of quantity or cross-section be taken up and reported on at a subsequent meeting by the Committee on Ballasting jointly with the Committee on Roadway.

Mr. Baldwin:—I am willing to accept that as an amendment.

The President:—The vote is on the amendment as proposed by Mr. Trimble; that is, practically, that the matter be deferred and treated by the Track and Ballast Committees jointly. Is that correct?

Mr. Trimble:—The subject of dimensions to be referred to these two committees, to bring in a joint report subsequently.

Mr. Baldwin:—As I understand, we are going to get action from the Committee on the question, but I think Mr. Trimble's point is a good one. We have now before us the character of the ballast, and I am willing to accept that amendment, and it is referred back to the Committee on two different lines.

The President:—The question is on the amendment to the amendment by Mr. Trimble.

Mr. Cushing:—That amendment is out of order as not being pertinent to the question.

Mr. Barnard:—I made that motion. There is a slight difference—that those two committees be combined.

Mr. Baldwin:—There was no amendment before the house when Mr. Cushing was discussing it before, but now there is a motion and an amendment before the house.

Mr. Trimble:—I said I proposed to solve the difficulties we were in by eliminating all of the specifications referring to quantity of ballast in the track and only consider the quality, and that the matter of quantity of ballast in the track be referred back to the Committee on Ballast to bring in a joint report with the Committee on Track as to the proper quantity for an ideal track; also for second-class or third-class track if advisable.

Mr. Mountain:—This Committee is not on Ballast; it is Ballasting, and there is quite a difference. If it is on Ballast, it is the quality of the ballast. If it is on Ballasting, it seems to me quite in order to give the depth of the ballast in the track. If they change the name and put down "Ballast," it stands in the same condition as the Committee on Ties—it was not tieing. If this Committee is on Ballast, they are wrong in saying how much in quantity should go into the track.

The President:—The title of the Committee is "On Ballasting."

Mr. Trimble:—That was a point I was going to make, that according to the heading of this report, it is a report of the Committee on Ballasting. The Committee on Ballasting is very closely allied to the Committee on Roadway. These people have studied the specifications for ballast, and they certainly must have some ideas as to the proper amount of ballast, and the Committee on Track ought to have some ideas and they should get together.

Mr. Hanna:—Which Committee are we to work with? The gentleman has mentioned Track Committee at one time and at another the Roadway Committee.

Mr. Trimble:—Track Committee.

The President:—The outline as originally drawn is somewhat defective and will probably have to be revised. The motion is to refer it to the Track and Ballasting Committees jointly.

(The amendment was carried.)

The President:—Under that motion clause 3 is referred back.

Mr. Trimble:—It is eliminated from the specifications entirely, referred back for consideration, and it should not be in the specifications according to the point I made.

The President:—It is understood that way. Mr. Cushing, you sought to bring in another matter just now. We will be glad to hear from you now.

Mr. Cushing:—That is what I proposed, that clause 3 be stricken out. I simply thought that there ought to be added to the specification something in regard to breaking up slabs, and I would imagine the Committee would not find any objection to anything of that sort.

The President:—The Committee will take that into consideration.

Mr. Barnard:—There has been so much discussion during the last few minutes about the different classes of track, that if it is in order I would like, so that it will be of record here and will not have to be

gone through with whenever this matter is brought up again, that in the joint consideration of this subject by the two committees only one standard of roadway be dealt with.

The President:—That is practically a motion to reconsider and would have to be made by a gentleman who voted in the majority. That nullifies the other motion.

Mr. Tye:—I do not quite see why it is a motion to reconsider. There was nothing in that amendment that stated how many standards there should be.

The President:—Did you vote for it, Mr. Tye?

Mr. Tye:—I voted for it.

Mr. Barnard:—I voted for it in the same way.

The President:—The motion stated that the three classes should be considered. You have heard the motion—practically a motion to reconsider, gentlemen. Discussion on that motion is in order.

(The motion was lost.)

Mr. Barnard:—I would like to ask for information. Was that in Mr. Trimble's amendment—three classes of track?

The President:—Mr. Trimble made a motion in lieu, practically.

Mr. Barnard:—Then we have not adopted Mr. Baldwin's motion.

The President:—Mr. Baldwin moved that they consider three classes of tracks—A, B and C.

Mr. Trimble:—When I made the motion I did not refer to any number of classes they should consider. I thought if they wanted to bring in one, two or three different classes or sets of dimensions they could do so. My idea was first to eliminate this matter of dimensions from the specifications; then refer back to the Committee on Ballasting to work with the Committee on Track. That may carry with it the idea of one, two or three classes of track, depending on how the Committee wants to look at it.

Mr. Baldwin:—I accepted that amendment.

The President:—The chair understood, and the mover of the amendment understood, that it carried with it the three classes of track.

Mr. Barnard:—I think it was understood by the majority of this convention that we were acting on Mr. Trimble's amendment, and that it did not carry with it the idea of three classes of track.

The President:—Then I suggest to the speaker that he make a motion to reconsider.

Mr. Barnard:—I make such a motion.

(The motion was lost.)

The President:—The result of that is that the sentiment of the convention is in favor of three classes of track. We have now completed the specifications as submitted. The conclusions are the next matter to be considered. The Secretary will read the conclusions.

The Secretary:—"While there is great variation in the qualities of the different natural materials for ballast, the choice of these qualities is not usually left to the engineer, but has been made already by nature, and all that is left to decide is what is most available or most expedient.

This each one must decide for himself in the light of his own circumstances. The question of finance may be a ruling consideration, or there may be but one thing to be had, and he must take that or nothing.

"In the case of crushed rock, however, there is a choice, and it is the conclusion of the Committee, in the light of arguments presented, that stone ballast made from hard, durable stone, broken in sizes from ¾-inch to 1½ inches, having a depth under tie of 12 inches, resting on a firm, well-drained roadbed, will best meet the requirements of roads with heavy traffic, large engines and fast service."

Mr. Kelley:—In the second conclusion, in view of the action of the convention on the size, should we not change 1½ inches to 2 inches, to be consistent therewith?

Mr. Cushing:—There is a misunderstanding on that. The specification was that it must pass through a 2-inch ring. That gives the size of the ballast 1½ to 1¾ inches.

The President:—The only inconsistency in that seems to be the thickness of 12 inches under the ties.

Mr. Barnard:—Should we not make a recommendation that, in view of the action taken by the convention on the specifications, this second conclusion be referred to that same joint committee?

The President:—It does not appear necessary to refer that to the joint committee, as the first part of the conclusion covers the matter that we have already taken favorable action on.

Mr. Cushing:—I make the motion that we strike out the words "having a depth under the tie of 12 inches."

The President:—The conclusion will then read: "In the case of crushed rock, however, there is a choice, and it is the conclusion of the Committee, in the light of arguments presented, that stone ballast made from hard, durable stone, broken in sizes from ¾-inch to 1½ inches, resting on a firm, well-drained roadbed, will best meet the requirements of roads with heavy traffic, large engines and fast service."

Mr. Hanna:—I suggest, if you leave the last few words in there—heavy traffic, large engines and fast service—that we need the depth under the tie. The trouble with the Committee is that it does not understand what the convention wants to get at. Does it want us to say anything about the class of road the ballast is to be used for?

Mr. Camp:—I understand that the motion before the house seeks to get at the quantity of the ballast and leave the depth of it to the joint committee.

The President:—That is the point.

Mr. Mountain:—The word "be" would make it a clear and logical sentence and would cut out entirely the question of what kind of traffic it was for.

The President:—In order to cure the difficulty, it is moved and seconded that the word "be" be inserted after the word "ballast," in the next to the last line, on page 40.

(The motion carried.)

REPORT OF COMMITTEE NO. V.—ON TRACK.

To the Members of the American Railway Engineering and Maintenance of Way Association:

The report of the Committee on Track for 1903 was not discussed in the convention for lack of time, and is now submitted with the following supplementary report:

Your Committee on Track was unable to make the dynamometer tests to determine the relation between excess elevation and train resistance, referred to in last year's report; it still hopes to be able to make this test and report fully on the question.

The suggestion of the Committee of 1902, that a special committee be appointed to consider jointly with a committee of the American Railway Master Mechanics' Association the subject of widening gauge on curves, has not been carried out, and this Committee has followed the matter no farther.

This Committee was instructed by the Board of Direction to confer with the Committee on Rail on the subject of standard drilling. In order to get some idea of current practice, about seventy-five inquiries were mailed to prominent roads, replies being received from nearly all of them, representing about 113,000 miles, showing a very wide divergence; and while we realize that some concessions will have to be made if a standard is ever established, we feel that the difference in many cases is so small that there is not much room for disagreement, except the inconvenience during the transition period.

The suggestion of the rail manufacturers to make the rail drilling 2½ in. and 5 in., which necessitates that the provision for expansion be put in the splice punching, thus making uneven punching in the splices, does not meet with the favor of this Committee.

A joint meeting of the committees on Track and Rail was held in Chicago, on September 28, 1903, at which there were present F. E. Abbott, G. B. Woodworth and H. F. Baldwin (vice S. M. Felton), for the Committee on Rail; and E. H. Lee, F. R. Coates, John C. Sesser and the Chairman of the Committee on Track. This joint committee agreed to recommend the following for standard drilling:

End of rail to center first hole.....2 13-32 in.
Center of first hole to center second hole.....5 in.
Center of second hole to center third hole.....5 in.

Diameter of hole in rail to be 3-16-in. larger than diameter of bolt used.

The punching in splices to be alternately oblong and round, to permit staggering the bolts in rail high enough to allow it without flange interference. The round hole (diameter) to be 1-16 in. larger than the diameter of bolts over thread.

It is generally conceded that for variations of temperature from —30 to +120, a 30-ft. rail will expand about ⅜ in. If the center remains stationary, one-half of this, or 3-16 in., will be the movement at each end, and the 3-16 in. between diameter of bolt and hole in rail will just permit this. There is a tendency among some engineers to reduce this allowance in the heavier rail now being used. At the same time, there is a tendency toward rails 33 ft. long, so that it is probable the above-mentioned allowance will still be satisfactory for the 33-ft. rails. Where 45-ft. or 60-ft. rails are used, a corresponding allowance for expansion will have to be provided for, but this Committee can not make any recommendations for 60-ft. rails at this time.

Your Committee was requested to report on the current practice and advisability of blocking frogs, guard rails and switches.

Replies received from 87 roads, representing about 140,000 miles, favors blocking in the proportion of about 3½ to 1.

Some of these favor only metal blocking, attached securely to the rail, but while your Committee believe the very best obtainable should be used, we believe that any blocking is better than none, as tending in some measure to prevent loss of life and limb.

The experience of those who have used oak blocking, cut to fit the rail-section and applied with carriage bolts, is very satisfactory.

SUMMARY OF CONCLUSIONS CONTAINED IN PREVIOUS REPORTS.

1900: No conclusions submitted.

1901: No conclusions submitted.

1902: Recommendations as to adjustment of tangents; adjustment of curves; methods of securing and maintaining perfect line; elevation of curves; vertical curves, and proper methods of tamping were submitted and adopted (see page 66, Vol. 3, 1902).

1903: The report was not considered by the convention for lack of time.

HISTORICAL.

General.—History states that the Romans used large, smooth slabs of stone as track, and it is evident that as soon as man became aware of the benefits to be derived from a smooth roadway, he commenced to lay track.

Track as we know it had its origin in the coal mining districts of Great Britain during the latter part of the seventeenth century. It consisted of rails of square oak timbers laid straight and parallel to each other, and held to place and gauge by oak cross-ties and treenails.

Roger North, in 1672, in his biography of his brother, Francis, Lord Chancellor, describes a wooden railway which he had seen at Newcastle, during the reign of Charles II., as follows: "The manner of the carriage is by laying rails of timber exactly straight and parallel, and bulky carts are made with rowlets fitting these rails, whereby the carriage is so easy that one horse will draw 4 to 5 chaldrons of coal, or about 8 or 9 tons."

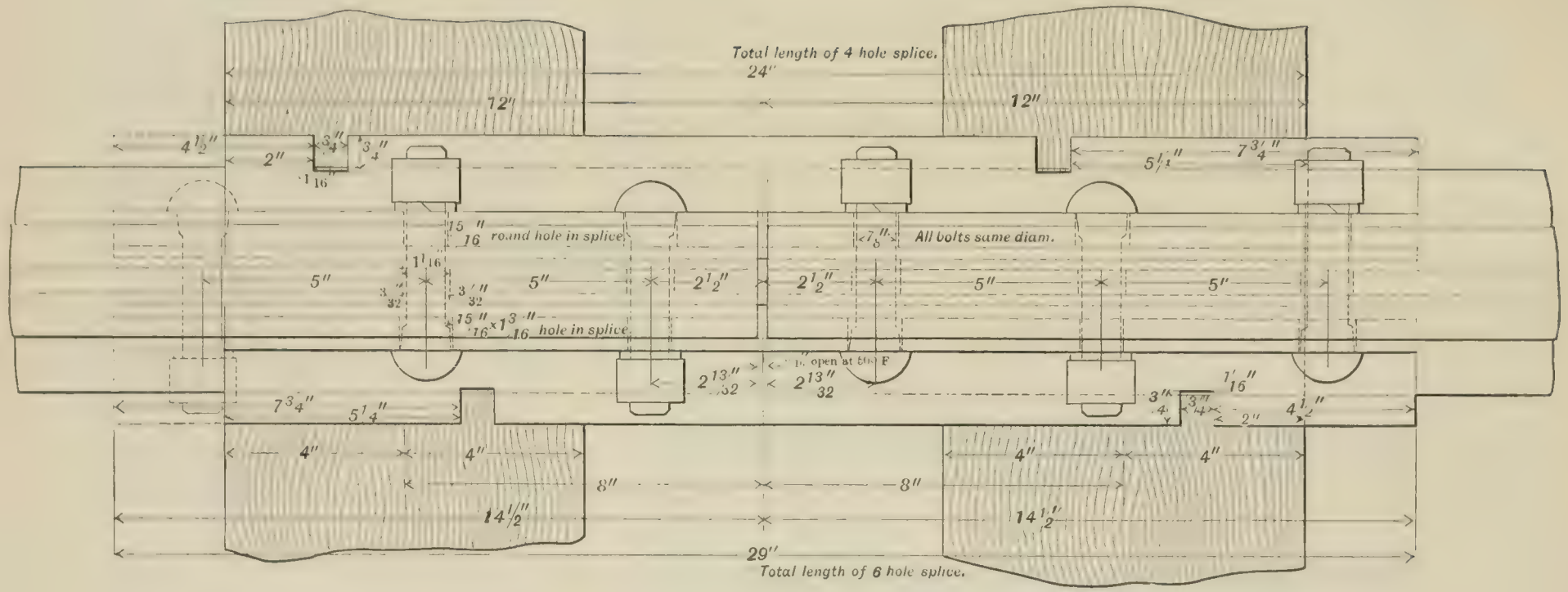
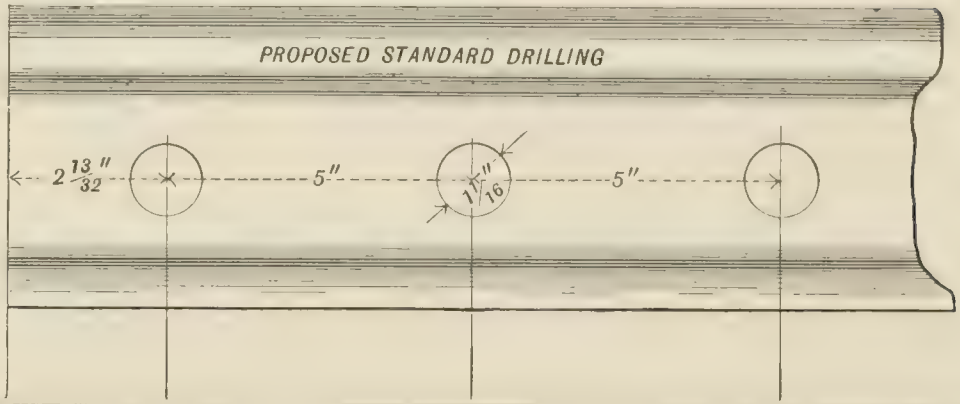


FIG. 1.—PLAN OF FOUR-BOLT AND SIX-BOLT RAIL JOINT RECOMMENDED BY COMMITTEE ON TRACK.

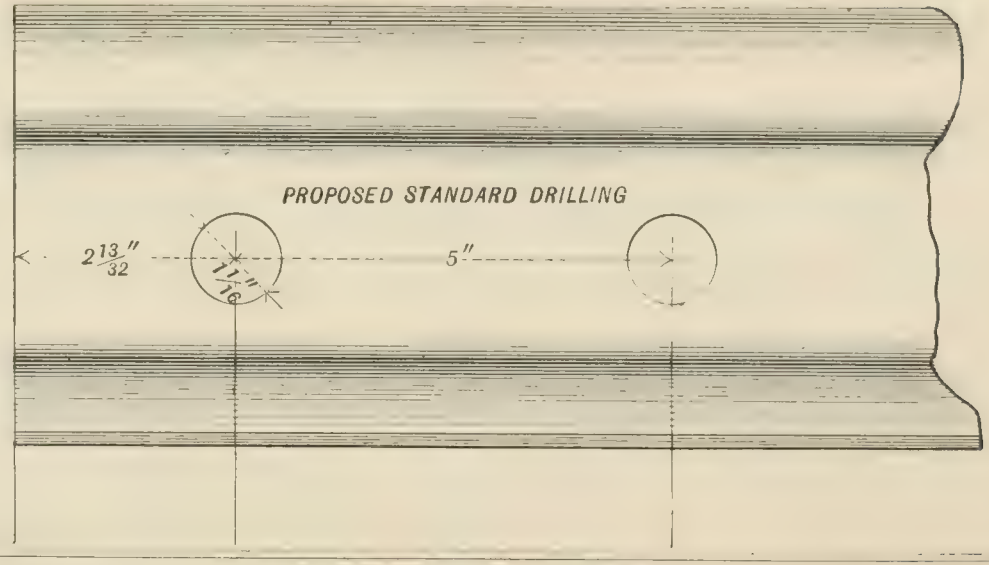
CHART SHOWING RELATION BETWEEN PRESENT PRACTICE IN RAIL DRILLING AND DRILLING RECOMMENDED BY COMMITTEE ON TRACK.



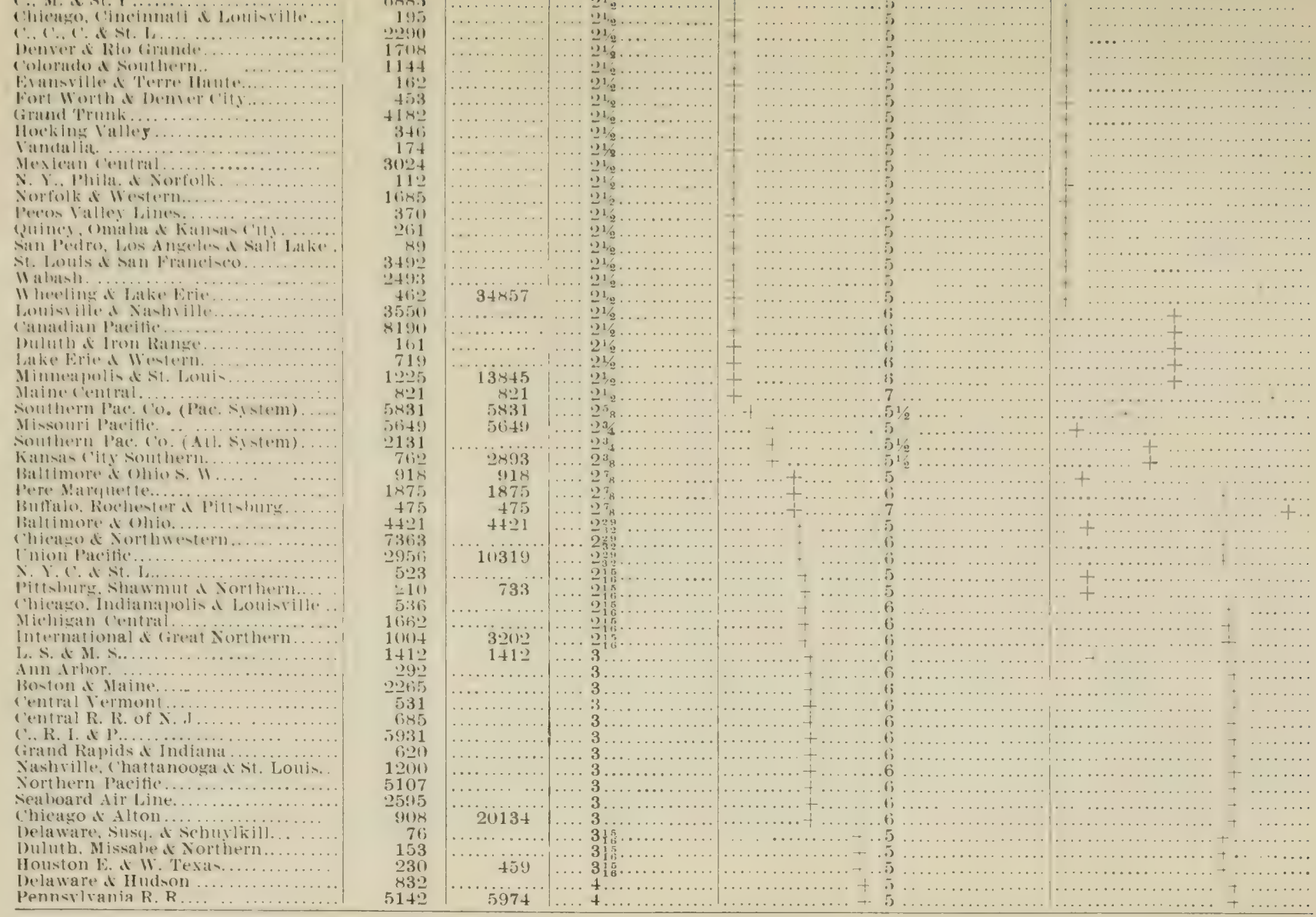
RAILROAD.	Mileage.	Total No. Miles Using each Drilling.	Inches.	Inches.	Inches.	
Delaware, Susquehanna & Schuylkill	76	76	1 3/8 +	5 +	5 +	
Southern	7124		1 [illegible] +	5 +	6 +	
Pennsylvania	7142		1 [illegible] +	5 +	6 +	
Lehigh Valley	1342	15608	1 [illegible]	4 +	4 +	
Nashville, Chattanooga & St. Louis	1200		1 [illegible] +	4 +	5 +	
Phila. & Reading	1468	2668	1 [illegible] +	4 +	5 +	
Chesapeake & Ohio	1637		1 [illegible] +	5 +	6 +	
Chicago, Indianapolis & Louisville	536	2173	1 [illegible] +	5 +	6 +	
Central R. R. of N. J	685		2 +	4 +	5 +	
Long Island	396	1081	2 +	4 +	5 +	
Delaware & Hudson	832	832	2 +	4 15/32 +	4 15/32 +	
Louisville & Nashville	3550	3550	2 +	4 1/2 +	6 +	
Alabama Great Southern	309		2 +	4 3/4 +	4 3/4 +	
Cincinnati, New Orleans & Tex. Pac.	336	645	2 +	4 3/4 +	4 3/4 +	
Central New England	197		2 +	5 +	6 +	
Duluth & Iron Range	161		2 +	5 +	6 +	
Pittsburg, Shawmut & Northern	210	2107	2 +	5 +	6 +	

Illinois Central	5312	5312	2 13/64	4½	9		
Great Northern	4659	4659	2¼	4½	7		
Boston & Albany	392	392	2¼	4¾	6⅞		
Chicago, Burlington & Quincy	2917		2⅜	5	5		
Hannibal & St. Joseph	1301	4218	2⅜	5	5		
Chicago Great Western	1321		2⅜	5	6		
Missouri Pacific	5649	6970	2⅜	5	6		
Chicago & Alton	908		2 11/32	4½	4½		
Southern Pacific Co	5831		3 13/32	4½	4½		
Union Pacific	2956	9695	2 13/32	4½	4½		
Gulf, Colorado & Santa Fe	1202	1202	2 13/32	5	5		
Penna. Lines West of Pittsburg	2672	2672	2 13/32	5	6		
Kansas City Southern	762	762	2½	4½	4½		
C., M. & St. P.	6885		2½	5	5		
Colorado & Southern	1144		2½	5	5		
Ft. Worth & Denver City	453		2½	5	5		
Pecos Valley Lines	370		2½	5	5		
St. Louis & San Francisco	3492		2½	5	5		
Quincy, Omaha & Kansas City	261		2½	5	5		
Atchison, Topeka & Santa Fe	4913	17518	2½	5	5		
Chicago, Cincinnati & Louisville	195		2½	5	6		
C., C., C. & St. L.	2290		2½	5	6		
Hocking Valley	346		2½	5	6		
N. Y., Phila. & Norfolk	112		2½	5	6		
Norfolk & Western	1685		2½	5	6		
Wabash	2493	7121	2½	5	6		
Minneapolis & St. Louis	1225	1225	2½	5	7		
Canadian Pacific	8190	8190	2½	6	6		
N. Y. C. & H. R.	2881	2881	2.75	5.6	5.6		
Southern Pacific Co.	2131	2131	2¾	5½	5½		
Texas & Pacific	1708		2⅞	6	6		
St. Louis Southwestern	1309	3017	2⅞	6	6		
Buffalo, Rochester & Pittsburg	475	475	2⅞	7	7		
Michigan Central	1662	1662	2 15/16	6	6		
Duluth, Missabe & Northern	153	153	2 15/16	6	9		
Boston & Maine	2265		3	6	6		
Seaboard Air Line	2595	4860	3	6	6		
Detroit & Mackinac	329	329	3	6	9		

CHART SHOWING RELATION BETWEEN PRESENT PRACTICE IN RAIL DRILLING AND DRILLING RECOMMENDED BY COMMITTEE ON TRACK.



RAILROAD	Mileage.	Total Miles Represented.	Inches.	Inches.
Mobile & Ohio	876		1 29/32	7
Pittsburg & Lake Erie	180		1 29/32	7
Southern	7124	8180	1 29/32	7
Chesapeake & Ohio	1637	1637	1 15/16	5
Alabama Great Southern	309		1 15/16	7
C. N. O. & T. P.	336		1 15/16	7
New Orleans & Northeastern	504		1 15/16	7
Phila. & Reading	1468	2617	1 15/16	7
Kansas City, Mexico & Orient	235	235	2 1/8	5 1/2
Illinois Central	5312	5312	2 1/8	4 1/2
Detroit & Mackinac	329	329	2 1/4	4 1/2
Boston & Albany	389	389	2 1/4	4 3/4
Chicago Great Western	1317		2 3/8	5
Missouri, Kansas & Texas	2512	3829	2 3/8	5
Gulf, Colo. & Santa Fe	1202	1202	2 13/32	5
Bessemer & Lake Erie	220		2 13/32	5
Chicago & Eastern Illinois	737		2 7/16	5
Southern Indiana	148		2 7/16	5
Tennessee Central	204		2 7/16	5
Wisconsin Central	891	2200	2 7/16	5
Atchison, Topeka & S. Fe	4913		2 1/2	5
Central New England	197		2 1/2	5



The development of the mining of coal and iron, and the consequent reduction in the price of iron, soon made it possible to use iron as rails in the construction of track. The first iron used was in the form of cast plates about 4 ft. long, 3 in. wide and about ¾ in. thick. These plates were used on the oak rails where the wear was greatest, and were what is known as our first "strap rail."

Primarily, there were two kinds of track; one in which the edge rails were used, where the flange was on the rail, and the other, in which the flat head rail was used, with the flange on the wheel. The advancement of track construction was naturally very closely allied to the development of the rail—they were coexistent. In 1767 we had for use in track the first cast rail, which was only 3 ft. long. Later a length of 6 ft. was obtained, and in 1815 rails had reached a length of 15 ft.

The introduction of the rolled iron rail in 1784 gave track its greatest development. The first rolled rails were 12 ft. in length.

Track made the locomotive possible and practicable, and its invention soon followed track construction. The demand made for cheaper transportation of coal and heavy freight soon put man to thinking, and as a result we have in 1803 Trevithick's locomotive. Without doubt, had Trevithick had a properly constructed track, and had he given to the track a sufficient amount of thought and study, he would have become more famous as one of our first inventors of the locomotive.

American Track.—The first American track of which we have any record originated in the various mines of Pennsylvania and Virginia. In 1825 we find a few isolated coal tram-roads. The first track, however, which conformed to the present American practice was without doubt that built for the Camden & Amboy Railroad Company. Robert L. Stevens, the "Father of Track," was the president and chief engineer of this railroad company in 1830, and to him is due the credit of the invention of the "T" rail, with a base, and also the method of fastening the same by means of the "hook-head" spikes.

J. Elfreth Watkins, in his article on "The Development of American Rail and Track," Transactions Am. Soc. C. E., Vol. XXII., gives an interesting account of the difficulties Mr. Stevens overcame in securing the first Stevens rail. He says: "From an examination of the minutes of the Board of Directors of the Camden & Amboy Railroad, September, 1830, I find that in the instructions given to Robert L. Stevens, as President and Chief Engineer of that company, who had been ordered to visit England to inspect and report upon railroad matters, was to purchase all-iron rails, which the management of that company preferred to the wooden rail plated with strap iron."

Mr. Stevens sailed a few days later, and it was during the voyage that he designed the first rail ever rolled with a base, whittling several cross-sections out of wood, which he obtained from the ship's carpenter.

He was familiar with the Birkenshaw rail, with which the best English roads were then being laid, but he saw that as it required an expensive chair to hold it in place, it was not adapted to our country, where metal-workers were scarce and iron was dear. He added the base to the "T"

rail, dispensing with the chair. He also designed the "hook-headed" spike (which is substantially the railroad spike of to-day), and the "iron tongue" (which has been developed into the fish-bar), and the rivets (which have been replaced by the bolt and nut) to complete the joint.

TIES.—It is interesting to note the various materials used for ties—stone, wood, iron, piles, concrete and paper. The cross-tie of to-day was used at first as a temporary substitute for something better, and its discovery was accidental. On account of the delay of the delivery of stone blocks, which were to be used as rail rests, the engineer of the Camden & Amboy Railroad used temporarily wooden cross-ties. It was found that they made a much better track and were used from that time on.

The original track of the coal mines of England was laid on longitudinal sleepers, held to place by cross-pieces. These sleepers were oak, and they allowed the use of a much lighter rail. The Baltimore & Ohio Railroad in 1833 had in its track stone sleepers, capped with the ordinary "strap rail." This form of construction was a favorite American device, and was supposed to represent the best American practice at that time.

Mr. Stevens, in building his line over swampy and low places, drove ties, the tops of which formed a true grade, and fastened the rail directly to them.

SPIKES.—Wooden treenails were first used to hold the wooden rail in place; they were the original track spike, or fastening. In England fang bolts were used as one of the early track fastenings. These bolts were of sufficient length to pass through the tie and screw into a nut on the under side. On the side of the nut was a fang which held it to place. Later we have the wedge spike. This was simply a spike split at the bottom for receiving a wedge. When the spike was driven to place, the wedge split the spike and caused it to assume a dovetail shape.

Robert L. Stevens invented the "hook-head" spike about 1830, and this spike, with but slight changes, is our railroad spike of to-day.

JOINTS.—That the weakest part of the track is at the joint seems to have been realized when track was first constructed, and it is interesting to note the various designs used on our early railroads. In 1789 the rails were so constructed that near the end they had a flat, projecting base, in which were holes for the bolts which fastened them together, and this held them to place. In 1797 the first iron chairs were adopted. They held the "T" rail in place by means of one bolt at either end. Many styles of chairs for the "T" rail were invented, and some can still be found in the yards of our secondary lines of to-day.

In 1804 we have the rail held to place by means of one square-headed iron spike (countersunk). The spike fitted into a square notch in each end of the rail.

In 1808 there was invented a rail which did away with the bolts and chairs at the joints. Projecting pins were cast on the bottom of the rail, at the points where the stone supports came; these joints were dovetailed into each other, thus dispensing with any other form of joint fixtures.

In 1816 we have the lap joint, through which a horizontal pin passed, fastening both rails.

In 1824 the miter joint was used in England on the Helton Colliery Road.

In 1837 the Camden & Amboy Railroad used the first fishplate with a screw bolt.

In 1850-55 rolled fishplates came into use. The Phœnix Iron Company of Phœnixville, Pa., manufactured splice bars at that time.

In 1840 experiments were made with wooden block joints. In about 1860 Eastern roads adopted standard wooden joints. They consisted of a wooden block 4 ft. long on the outside of the rail and a short splice bar on the inside. This was a four-bolt joint, and at one time was used as standard on the Pennsylvania Railroad.

In 1850 the slot rail and ring joint were used. A slot about 2 in. long was cut in the web of the rail at each end; into these slots rings were fitted. These rings encircled the base of the rail, to which they were secured by a key being driven on each side of the flange, between the ring and the rail flange.

The angle bar first made its appearance as early as 1857, when it was used as an experiment on the Erie Railroad.

Frogs and Switches.—The original frogs and switches were very crude in their construction. In 1859 Joseph Wood, of Red Wing, N. J., invented a frog which is practically our frog of to-day, and formed a basis of our many existing types.

Gauge.—The establishment of a standard gauge on railroads has caused the most bitter of railroad contests. In 1690 we find the wooden track of the coal mines of England had a gauge of 5 ft. This measurement, however, was from the outside of the rail, the inside measurement being 4 ft. 8½ in. This adopted width of gauge seems to have been accidental and made to fit the wagons then in use. By the introduction of railway vehicles, many experiments were made with various gauges, and it seems to have been a matter of local adoption.

The variation of gauges in America exceeded that of all other countries. Track had been laid with gauge varying from 10 in. to 7 ft. In England, in 1848, after the battle of gauges, 4 ft. 6 in. and 5 ft. 7 in. were dropped and the 4-ft. 8½-in. gauge adopted as standard, to be used in all new roads with the exception of those using 7 ft.

The Great Western Railway of England used the 7-ft. gauge until 1892; this seems to have been the widest used.

India has a gauge of 5 ft. 6 in., so established by law. It is claimed that this gauge was used because of the advantage it afforded for the convenient arrangement of the machinery of the locomotive.

In Europe the various governments have been instrumental in establishing a uniformity of gauge. One of 4 ft. 8½ in. is compulsory in England, France, Belgium, Italy and Germany. Russia has a gauge of 5 ft., Spain 5 ft. 6 in., and Ireland 5 ft. 3 in. In this country there has been no law passed establishing a uniform gauge. In 1830 Knight recommended 4 ft. 9¼ in.

The Mauch Chunk road had a gauge of 3 ft. 6 in. The 5-ft. gauge seems to have been extensively used in the South. The 4-ft. 8½-in. gauge

was more generally used in the Central and Western states and has been universally adopted as standard in order to facilitate the easy transfer of through traffic.

The 4-ft. 8½-in. gauge was adopted as standard by the American Railway Association April 7, 1897.

ALINEMENT.—The earlier railroads gave very little thought to alinement, and the use of 14- and 30-degree curves was of frequent occurrence. In 1828-29 the easement by transition curves was first suggested. One method, by Mr. Gravatt, consisted of the curve of sines, or a parabola, without the use of any circular arc, and one method, by Dr. Wm. Froude, consisted of a circular central part, with flattened ends, corresponding to the present spiral or cubic parabola. Among the first to advocate the use of easement curves in this country was Mr. A. M. Wellington, who, in 1881, suggested the use of compound curves, beginning with 50 ft. of one-degree curve, succeeded by 50 ft. of 2-degree curve, and proceeding so to compound every 50 ft. until the last 50 ft. was one degree less than the central part of curve.

Later, Mr. Wellington suggested a form of easement curve which agrees closely with the cubic parabola. The frequent use of some form of easement curves began about this time. Following this came the development of the various types and formulas which are now generally employed by first-class railroads.

CONCLUSIONS.

Your Committee submits for adoption the following conclusions and recommendations:

(1) That the definitions of terms submitted in the 1903 report be adopted.

(2) That the recommendations under the headings of "Maintenance of Line," "Maintenance of Surface" and "Maintenance of Gauge" of the 1903 report be approved.

(3) That the standard drilling for rails be as follows:

End of rail to center first hole.....2 13-32 in.
Center of first hole to center second hole.....5 in.
Center second hole to center third hole.....5 in.

Diameter of hole in rail to be 3-16 in. larger than diameter of bolt used.

The punching in splices to be alternately oblong and round, to permit staggering bolts in rail, high enough to allow it without flange interference. The round hole (diameter) to be 1-16 in. larger than the diameter of bolts over thread.

(4) That the heel of all frogs be made with a steel filler block, to fit the section of rail securely bolted in, with the outer end of filler planed off ⅜ in. below top of rail, to act as a riser for the outer edge of worn treads.

(5) That the wings and throat of all frogs be blocked with a metal

or wood blocking, shaped to fit rail-section; give 1½ in. flange clearance, and securely bolted to frog.

Respectfully submitted,

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E. H. LEE, *Vice-Chairman;* Engineer and General Roadmaster, Chicago & Western Indiana Railway, Chicago, Ill.

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Committee.

FOURTH ANNUAL REPORT.*

At the last convention of the Association, it was decided that there was not enough time to consider the report submitted as a whole. It was accepted as a report, and referred back to the Committee, who were instructed to present it for final action this year. Subsequently instructions were received in Bulletin No. 28 to confine the report to:

(1) Definitions.
(2) Maintenance of Line.
(3) Maintenance of Surface.
(4) Maintenance of Gauge.

(1) DEFINITIONS.

TRACK.—Ties, rails and fastenings, with all parts in their proper relative places.

*ALINEMENT.—The location of the road with reference to curves and tangents.

LINE.—The condition of the track in regard to uniformity in direction over short distances on tangents, or uniformity in variation in direction over short distances on curves.

TANGENT.—Straight track.

*CURVE.—A series of changes in direction according to a regular method.

*CURVE, SIMPLE.—A series of uniform changes in direction according to a fixed method.

CURVE, EASEMENT.—A curve of regularly varying radii, connecting a tangent to a simple curve, or connecting two simple curves.

CURVE, VERTICAL.—A curve used to connect intersecting grade lines.

SURFACE.—The condition of the track as to vertical evenness or smoothness over short distances.

*LEVEL.—The condition of the track as to the equal elevation of the rails transversely.

ELEVATION (as applied to curves).—The amount which the outer rail is raised above the inner rail.

*GAUGE (of Track).—The shortest distance between the inside of the heads of the two rails forming the track, the same to be measured between parallel surfaces, perpendicular to the plane through tops of the two rails, and projecting 1⅜ inches below this plane.

GAUGE, STANDARD.—The gauge of 4 feet 8½ inches.

*GAUGE (Track Tool—Standard Specifications).—The gauge recommended shall be a wooden bar with parallel metal measuring surfaces fastened rigidly to it. These measuring surfaces shall be perpendicular to plane of top of rails and shall extend to a depth of 1⅜ inches below same.

*(2) MAINTENANCE OF LINE.

(a) Adjustment of Tangents:

Recommendations: Tangents shall be adjusted by throwing the tangent between summits; between curves; or by throwing curves to meet

*See amendments, page 535. †Reprint of the 1903 report.

tangent; or by partially throwing curves and partially throwing tangents, as may require the least work. Centers should be set with transit to insure accurate line.

(b) Adjustment of Curves, with Consideration as to Easement Curves:

Recommendation: Easement curves shall be used as follows:

For speed not exceeding 30 miles per hour, on all curves exceeding 2 degrees.

For speed not exceeding 60 miles per hour, on all curves exceeding 1 degree.

Where higher speed is attained, on all curves exceeding 30 minutes.

Easement curves shall be used between curves of different degrees in the same way that they are used between curves and tangents.

*The length of easement curves shall be the same as the distance in which the curve elevation is run out; therefore, as the superelevation of curves depends not alone on the degree, but also on the speed of trains, the length of the easement curve should vary in the same manner.

For ordinary practice, a chord length equivalent to 100 feet for each degree of variation in curvature is recommended.

Where the distance between curves will not allow this, or for other reasons, a chord length of 25 to 30 feet may be used.

For very high-speed roads, a chord length equivalent to 150 feet or more per degree of variation is recommended.

Your Committee believes that any form of transition curve is satisfactory which gradually changes the degree of curvature, and in which the length of chord per degree of variation can readily be changed to suit each particular case, the essential point being that the length of the easement curve shall be the same as the distance in which the elevation of the outer rail is raised from zero to full elevation.

We recommend any transition curve of the type of the Searles, Crandall, Holbrook, Talbot or cubic parabola, which shall be susceptible of being run in by deflection or offset.

(c) Method of Securing and Maintaining Perfect Line:

Recommendations: Permanent witnesses shall be placed at points of tangent, points of spiral, points of change of curvature, summits, and at such other points along curves or tangents as will enable the alinement to be identically reproduced with a transit.

(3) MAINTENANCE OF SURFACE.

(a) Elevation of Curves, with special consideration as to amount and beginning and end of elevation, and as modified by location of curve and conditions of traffic:

Your Committee advises that the approximate formula,

$$e = \frac{Gv^2}{32.16\,R}$$

in which

e = Elevation in feet,
G = Gauge of track,
v = Velocity in feet per second,
R = Radius of curve in feet,

will give essentially correct theoretical elevation for the outer rail of curves,

*See amendments, page 535.

and is recommended for ordinary practice, but must be modified as noted below to suit special conditions.

For greater convenience the formula above may be further reduced by substituting,

$$v = V\frac{5280}{3600},$$

$$G = 4.708,$$

$$R = \frac{5730}{D} \text{ (approx.)},$$

$$e = 1\text{-}12\ E,$$

in which V=Velocity in miles per hour,
D=Degree of curve,
and E=Elevation of outer rail in inches;
whence $E = .00066\ DV^2$.

This formula will give results which are expressed in the accompanying table.

ELEVATION OF OUTER RAIL IN INCHES.

Degree of Curve	Velocity in Miles per Hour.													Degree of Curve.
	10	15	20	25	30	35	40	45	50	55	60	65	70	
1	0	1/8	1/4	3/8	5/8	3/4	1 1/8	1 3/8	1 5/8	2	2 3/8	2 3/4	3 1/4	1
2	1/8	3/8	1/2	7/8	1 1/2	1 5/8	2 1/8	2 5/8	3 1/4	4	4 3/4	5 1/2	6 1/2	2
3	1/4	1/2	3/4	1 1/4	1 3/4	2 3/8	3 1/8	4	4 7/8	6	7 1/8	8 3/8	9 3/4	3
4	1/4	5/8	1 1/8	1 5/8	2 3/8	3 1/4	4 1/4	5 3/8	6 5/8	8	9 1/2	.....	.....	4
5	3/8	3/4	1 1/4	2	3	4	5 1/4	6 5/8	8 1/4	.....	.....	.....	.....	5
6	3/8	1	1 5/8	2 1/2	3 1/2	4 7/8	6 1/4	8	.....	.....	.....	.....	.....	6
7	1/2	1 1/8	1 7/8	2 7/8	4 1/8	5 5/8	7 3/8	.....	.....	.....	.....	.....	.....	7
8	1/2	1 1/4	2 1/8	3 1/4	4 3/4	6 1/2	8 3/8	.....	.....	.....	.....	.....	.....	8
9	5/8	1 3/8	2 3/8	3 3/4	5 3/8	7 1/4	.....	.....	.....	.....	.....	.....	.....	9
10	3/4	1 1/2	2 5/8	4 1/8	5 7/8	8 1/8	.....	.....	.....	.....	.....	.....	.....	10
11	3/4	1 3/4	2 7/8	4 5/8	6 1/2	8 7/8	.....	.....	.....	.....	.....	.....	.....	11
12	7/8	1 7/8	3 1/8	4 7/8	7 1/8	.....	.....	.....	.....	.....	.....	.....	.....	12
13	7/8	2	3 3/8	5 3/8	7 3/4	.....	.....	.....	.....	.....	.....	.....	.....	13
14	1	2 1/8	3 3/8	5 3/4	8 3/8	.....	.....	.....	.....	.....	.....	.....	.....	14
15	1	2 1/4	3 7/8	6 1/4	8 7/8	.....	.....	.....	.....	.....	.....	.....	.....	15
16	1 1/8	2 1/2	4 1/4	6 5/8	.....	.....	.....	.....	.....	.....	.....	.....	.....	16
17	1 1/4	2 5/8	4 1/2	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	17
18	1 1/4	2 3/4	4 3/4	7 1/2	.....	.....	.....	.....	.....	.....	.....	.....	.....	18
19	1 3/8	2 7/8	5	7 3/4	.....	.....	.....	.....	.....	.....	.....	.....	.....	19
20	1 3/8	3 1/8	5 1/4	8 1/8	.....	.....	.....	.....	.....	.....	.....	.....	.....	20

Since the elevation required is a function of, and depends upon, the train speed, this speed is the first element to be determined.

In general, as a matter of safety, the preference should be given to fast passenger traffic. The slower freight traffic must also be considered, and it often happens that on freight lines the correct elevation for passenger service would be so excessive for freight service that the train resistance would be increased enough to materially reduce the tonnage hauled. In this case, a compromise must be made between the two rates of speed, and the curve elevation used will be too small for passenger service (theoretically), but practicable for freight service.

It is the intention of the Committee to obtain dynamometer tests during the coming year, which will show the relation between excess elevation and increased train resistance.

It must not be understood that it is unsafe to run over a curve at a higher rate of speed than that for which it is elevated. A train may, for example, safely run 10 miles per hour over a curve which has no elevation. In the same manner a train may safely run 60 miles an hour over a curve elevated for a speed of but 50 miles an hour. The practice of running over curves at a speed greatly in excess of speed for which they are elevated should be avoided. It results in increased flange and rail wear and cost of maintenance. The curves cannot ride perfectly and the danger of accident is increased.

The maximum allowable elevation of curves depends on local conditions. On fast passenger roads, where crushed stone or other stiff ballast is used, a difference in elevation of 8 inches is successfully maintained. Your Committee therefore recommends that for ordinary practice a maximum elevation of 8 inches shall be used, but that when greater elevation is required, speed shall be reduced until the 8 inches elevation gives satisfactory results.

The superelevation of curves shall be zero at the point of spiral and shall increase to full elevation at the end of the spiral or beginning of the simple curve.

In ordinary practice, it is recommended that the elevation be run out at the rate of 1 inch in 60 feet, but this will be modified by the same conditions that should vary the length of the easement curve used.

The inner rail shall be maintained at grade.

(b) Vertical Curves:

The use of vertical curves wherever changes occur in the rate of grade is so universal that it does not seem necessary to enter into a discussion of the reasons requiring it. The practice, however, in regard to the length of vertical curves, the rate of change in grade per station and the method of determining the vertical curve varies greatly on different roads.

In order to ascertain the rules in force in these respects inquiries were made of a number of chief engineers as to their methods in use. Fifty-four answers were received, which show as follows:

Formula:

Roads using some form of parabola	13
Searles' formula	7
Wellington's formula	5
Henck's formula	3
Graphical method	3
Special rules based on circular curves or parabola	13
No fixed practice	10

Length of vertical curve arbitrarily fixed at:

300 to 600 feet	1
200 to 900 feet	9
600 to 1,000 feet	2
600 to 1,200 feet	2
400 to 1,800 feet	1
200 to 2,000 feet	2
400 to 4,000 feet	1
Fixed entirely by local conditions	5

Length of vertical curve determined by rate of change of grade per station:

0.3 on summits, 0.3 on sags	2
0.25 on summits, 0.08 on sags	1
0.2 on summits, 0.1 on sags	4
0.1 on summits, 0.1 on sags	2
0.1 on summits, 0.05 on sags	16
0.05 on summits, 0.025 on sags	1
Roads not reporting	5

From these figures it will appear that the practice, even on the best roads, is very irregular; that the balance of opinion favors a vertical curve between the limits of 200 and 900 feet in length; also that the balance of opinion is in favor of a rate in change of grade varying between 0.1 on summits and 0.05 on sags; and that the parabola, or some modified form of the parabola, is used in the majority of cases.

There appears to be no satisfactory theoretical basis on which this question can be discussed. The flatness of the curve required must be determined by practical experience, depending upon the length and speed of trains and the character of the equipment. The object should be to make the change from one grade to another in sags so gradual that trains will not bunch badly as the head end starts up the opposing grade.

Since the introduction of automatic couplers this action is much less to be feared than formerly. But little trouble can be caused at summits from short vertical curves, unless they are carried to a point where the middle ordinate of the vertical curves would bring the truss rods dangerously close to the ground, or unless a sag is so close to the summit that the slack would not have time to straighten out.

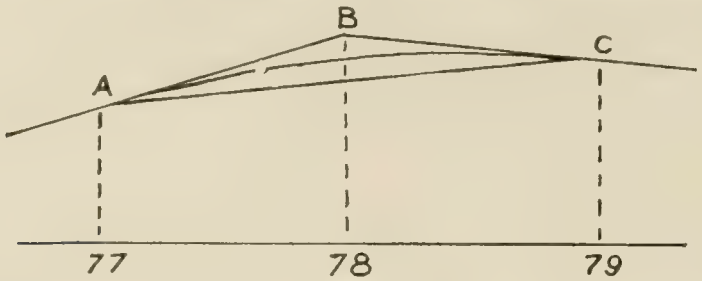
The length of the vertical curves used in new construction will, of course, depend largely on the character of the road to be built. On high-grade passenger lines we would recommend a rate of change of 0.1 on summits and 0.05 on sags, where same can be obtained without great cost. If, however, the resulting curves will be of excessive length, or, by reason of increasing the summit cuts or causing heavy fills, would add materially to the cost, there would be no serious objection to increasing the rate of change to 0.2 on summits and 0.1 on sags. These latter rates are recommended on all roads except high-grade passenger lines and roads carrying heavy traffic or running long freight trains.

Your Committee expects to give the maximum allowable rate of change per station for vertical curves used at the top or bottom of coal inclines or similar tracks.

Theoretically, the changes in the rate of grade for each station of the vertical curve should be equal. A section of a parabola as applied to this purpose so nearly approximates this condition that the following formula is recommended for practical use:

Let AB, BC be two grades in profile, intersecting at station B, and let A and C be the adjacent stations. It is required to join the grades by a vertical curve extending from A to C. Suppose a chord drawn from

A to C. The elevation of the middle point of the chord will be mean of the elevations of grade at A and C. One-half of the difference between



this and the elevation of grade at B will be the middle ordinate of the curve. Hence we have:

$$M = \tfrac{1}{2}\left(\frac{\text{grade A} + \text{grade C}}{2} - \text{grade B}\right)$$

in which M = the correction in grade for the point B. The correction for any other point is proportional to the square of its distance from A or C. Thus the correction at A + 25 is 1-16 M; at A + 50 it is ¼ M; at A + 75 it is 9-16 M; and the same for corresponding points on the other side of B. The corrections in the case shown are subtractive, since M is negative. They are additive when M is positive, and the curve concave upward. (See Searles.) It will be readily seen that by the use of this method the length of the curve may be varied at will to suit the condition of the ground or the rate of change per station desired.

It will be found that by using circular curves on the profile a trial curve can be rapidly platted which will indicate closely what curve the conditions of cut, fill, etc., will allow, after which the true parabolic curve may be readily calculated as above.

(c) Proper Methods of Tamping:

(1) Earth or Clay Ballast.—Recommendations:

Tools: Shovel equipped with iron cuff or handle for tamping; broad pointed tamping bars.

Work: Tamp each tie from 18 inches inside of the rail to end of tie with handle of shovel or tamping bar. If possible, tamp the end of the tie outside of rail first and let train pass over before tamping inside of rail; give special attention to tamping under the rail; tamp center of ties loosely with the blade of the shovel; the dirt or clay between the ties must be placed in layers and firmly packed with feet or otherwise, so that it will quickly shed the water; the earth must not be banked above the bottom of the ends of the ties; the filling between the ties must not touch the rail and should be as high as, or higher than, the top of the ties in the middle of the track.

(2) Cinder Ballast (Railroad Product):

Tools: Shovel, tamping bar or tamping pick.

Work: Same as for gravel.

(3) Burnt Clay Ballast:

Tools: Shovel only in soft material. When burnt very hard, tamping pick or bar should be used.

Work: Tamp 15 inches inside of rail to end of tie, tamping end of tie first, letting train pass before tamping inside of rail; tamp center loosely; tamp well between the ties; dress ballast same as for earth or cinders.

(4) Broken Stone or Furnace Slag:

Tools: Shovel, tamping pick, stone forks.

Work: Tamp 15 inches inside of rail to end of tie; if possible, tamp the end of the tie outside of rail first and allow train to pass over before tamping inside of rail; tamp well under the rail; tamp well under ties from end of same; do not tamp center of tie; fill in between ties to height of top of tie; bank ballast into shoulder about the end of the ties level with top of tie.

(5) Chat, Gravel or Chert Ballast:

Tools: Shovel, tamping pick or tamping bar. For light traffic, shovel tamping is sufficient. For heavy traffic, the tamping pick or tamping bar should be used. The tamping bar is recommended instead of the tamping pick for ordinary practice.

Work: Tamp solid from a point 15 inches inside of rail to the end of the tie; if possible, tamp the end of the tie outside of the rail first and allow train to pass over before tamping inside of rail; care must be taken not to disturb the old bed. Tie must be tamped solidly from the end, using pick or tamping bar. After train has passed, the center of the tie shall be loosely tamped with the blade of the shovel. Whether the material shall be banked around the ends of the ties or not will depend upon how well the ballast will drain.

(6) General:

When not surfacing out of face, as in case of picking up low joints or other low places, the general level of the track shall not be disturbed. Where the rails are out of level, but where the difference in elevation is not excessive and is uniform over long stretches of track, a difference in elevation between the two rails of ⅜ of an inch may be allowed to continue until such time as the track would ordinarily be surfaced out of face.

(4) MAINTENANCE OF GAUGE.

(a) Proper Method of Spiking:

(1) The gauge (tool) used shall be the standard gauge recommended.

(2) When track is intended to be spiked to standard gauge, the rail shall be held against the gauge with a bar while the spike is being driven.

(3) Within proper limits a slight variation of the gauge from standard is not seriously objectionable, provided the variation is uniform and constant over long distances. Under ordinary conditions it is not necessary to regauge such track when the increase in gauge has not amounted to more than three-eighths of an inch.

(4) All spikes shall be started straight, and so driven that face of

spike shall come in contact with base of rail; the spike should never have to be straightened while being driven.

(5) Outside spikes of both rails shall be on the same side of the tie, and the inside spikes on the opposite side of the tie. The inside and outside spikes shall be separated as far apart as the face and character of the tie will permit. The ordinary practice shall be to drive the spike 2½ inches from the outer edge of the tie.

(b) Allowance, if any, in gauge of curve, with consideration as to various practices.

At the last convention it was suggested by your Committee on Track that a special committee be appointed to consider this jointly with the committee of the American Railway Master Mechanics' Association, and we still believe that this is the best method of procedure.

The data which your Committee has collected during the year have shown widely varying results in different parts of the country. Some of the roads we find are flanging all tires and the road department is not reporting trouble in holding the curves, while on other roads of lighter curvature, where tires have been flanged, great trouble has been experienced, both in the wearing of the rail and in the maintenance of gauge. We, therefore, do not feel at the present time that we are justified in making any report on this subject, but we hope to collect enough data to be able to justify conclusions later.

*(c) Methods used to prevent spreading of track and canting of rails on curves.

Recommendations:

(1) For heavy traffic, use tie-plates on all ties on curves.

(2) For medium traffic, tie-plate all curves over 3 degrees.

(3) For light traffic, double spike the outside of rails.

(4) Tie-plates are recommended in preference to rail braces, except for guard rails and stock rails at switches, where the latter should be used.

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C. B. HOYT, Ch. Sup. Tr., N. Y. C. & St. L. R. R., Bellevue, O.;
H. C. LANDON, E. M. W., Buff. & Sus. R. R., Galeton, Pa.;
G. A. MOUNTAIN, Ch. Eng., Can. Atl. Ry., Ottawa, Can.;
D. MACPHERSON, Div. Eng., Can. Pac. Ry., Montreal, Canada;
J. C. SESSER, Kansas City, Mo.

Committee.

See amendments, page 535.

AMENDMENTS.

ALINEMENT.—The horizontal location of a railroad with reference to curves and tangents.

CURVE.—A change in direction by means of one or more radii.

CURVE, SIMPLE.—A change in direction by means of a single radius.

GAUGE (of Track).—(Referred back to Committee.)

GAUGE (Track Tool).—(Referred back to Committee.)

LEVEL.—The condition of the track in which the elevation of the rails transversely is equal.

COMPOUND CURVE.—A curve consisting of two or more simple curves of different radii, all in the same direction, joining one another at points with common tangent.

REVERSE CURVE.—Two curves in opposite directions in a continuous line joining at a common tangent point.

Change heading to read "Maintenance of Line and Alinement."

The length of easement curves shall be the same as the distance in which the curve elevation is run out; therefore as the superelevation of curves depends not alone on the degree, but also on the speed of trains, the length of the easement curve should vary in the same manner.

Methods used to prevent spreading of track and canting of rails.—(5) Tie-plates should be applied in all cases where greater economy in maintenance is secured by their use than in depending on the life of the tie limited by rail wear.

DISCUSSION.

Mr. H. G. Kelley (Minneapolis & St. Louis—by letter):—In the matter of correct diameter for drilling, I originally used 1⅛-in. diameter for ⅞-in. bolts, but finding that this permitted too much expansion and creeping of rails, I reduced it to $1\frac{1}{16}$-in. diameter, and have had but little trouble since. I am not, therefore, disposed to take any exception to a standard of 1-in. diameter, but would desire to learn the experience of others with this size hole before adopting or recommending it. A study of the possible rail movements within the limits of an ordinary joint, fastened with ⅞-in. bolts, and with 3-16 in. allowed for expansion in the splice bars, would indicate that $1\frac{1}{16}$-in. was nearly theoretically correct within the range of northern temperatures; but if the decrease in size to 1 in. would tend to restrict excessive creeping and accumulation of vacant spaces at certain joints and yet permit necessary expansion, it would be a benefit.

In the matter of the spacing of the bolt holes, a number of important features are involved, and I believe the spacing should vary with the style or principle of the joint used, and will depend in some measure upon the length of the bar.

With the ordinary angle bar, in which the bottom flange of the bar does not rest upon the tie or tie-plate, the length of the bar used and the spacing of the joint ties are not primarily entirely dependent upon each other, for in this style of joint the support rendered by the bars is in the nature of a splice at the center of a continuous girder, but in joints similar to the Continuous, or the Weber, the support is in the nature of a carrying girder acting with the rails themselves; the end supports or base plates of these girders being that portion of the bottom flanges of the joints resting upon the joint ties.

We must, therefore, give these joints as full a bearing as possible upon the ties to secure a perfect tie support, without rocking. Therefore, the center of gravity of the load upon each tie must be at least over the middle third of the tie, and this must be secured without allowing the ties to approach each other so closely as to interfere with ease of tamping and other track work.

With the ordinary run of ties, both oak and cedar, a plain angle bar can be used, having a length of 22 in. and the bolt holes in the rail spaced 2½ in. and 5 in.; but with the use of a bar of the continuous type, I believe the preceding conditions are best met with a joint 24 in. long. If then the holes are placed 2½ in. and 5 in. for this joint, we would have 4½ in. of joint projecting beyond the last hole, which is probably too much, but by changing the spacing to 2½ in. and 6 in. the projection is reduced to a safe limit, and the ideal joint conditions are probably secured.

In the case of a three-hole drilling, the joint becomes at least 36 in. long, with a supporting tie in the middle. Therefore the type of joint represented by the Continuous or Weber is not required, and we return to the simple angle bar, in which the spacing recommended by the committee of steel manufacturers for six-hole splice bars, namely, 2½ in., 5 and 6 in., has no particular objections, except the extension of 4½ in. beyond the last hole. I believe, therefore, that this spacing should be altered to 2½ in., 5 and 7 in.

Mr. Wm. Ashton (Oregon Short Line—by letter):—The suggestion that the standard specification for drilling steel rails, calling for one-inch holes, would imply the use of a track bolt of smaller diameter than ⅞ in. I have my doubts as to the advisability of using a bolt of smaller diameter than ⅞ in. on rail of 75 lb. to the yard or heavier. The percentage of failures of ¾-in. bolts in six-hole angle bars under heavy traffic leads me to believe that ¾-in. bolts are not economical with heavy rail and heavy traffic with the ordinary angle bar. There is, of course, a difference in the cold rolled bolts and the cut thread bolts. With a ⅞-in. bolt and ordinary oval punched angle bar my experience has been that a 1⅛-in. hole through the rail is necessary to get good working results. While with accurately punched bars and careful work on the part of the trackmen ⅞-in. bolts might be used with a one-inch hole through the rail, I would expect a loss of time and loss of material that would not compensate for the benefits of the ⅛-in. smaller hole through the rail.

As to the punching of angle bars or splices: The 2½ in. and 5 in. suggested for four-hole splices or angle bars would, in my opinion, prove satisfactory with the ordinary short angle bar. If, however, the angle bar is made more than 24 in. or 26 in. in length, it would seem to me that the 2½ in. and 6 in., or even 3 in. and 6 in., might hold this longer angle bar more closely to its work.

As to the punching for six-hole splices or angle bars: With a 40-in. angle bar, 3 in., 6 in. and 7 in. would seem to me to give a better distribution than 2½ in., 5 in. and 6 in.; with a 29-in. angle bar, 2½ in., 4½ in. and 5½ in. would give a better distribution than the punching suggested.

It would seem to me that with a standard punching we would be called upon to adopt a standard length for angle bars and splices. The 29-in., six-hole angle bar could not be well used on the same punching that would give the best results on a 40-in., six-hole angle bar.

Mr. R. Montfort (Louisville & Nashville—by letter):—In our rails the diameter of holes are one inch, same as proposed; spacing is 2 in., 4½ in. and 6 in. The usual spacing of ties at joints is 10 in. in the clear. Care should be taken to space the bolts so that they will not interfere with spikes, that is to say, so the spikes can be driven without striking the bolt heads. The spikes should also be staggered, and not driven opposite each other, which would tend to split the tie.

Mr. R. Trimble (Pennsylvania Lines—by letter) :—We are willing to accept any kind of drilling agreed on, provided the mills will concede something which will insure good wearing rails.

Mr. G. Bouscaren (Consulting Engineer—by letter) :—I do not think the Committee will be in a position to make definite recommendations before arriving at an agreement with the rail makers as to heat treatment and methods of inspection.

Mr. W. B. Poland (Baltimore & Ohio Southwestern—by letter) :—For heavy rail we are using ⅞-in. steel bolts; for 33-ft. rail drilling 1 1-16 in., and for 60-ft. rail drilling 1 3-16 in.

We use 26-in. angle bars, which are punched from the end to the first hole 5 in.; first hole to second hole, c. to c. 5 in., c. to c. center holes 6 in. We are not using the six-hole angle bars on any of our new rails.

Previously we used a ¾-in. bolt with 1 1-16 in. drilling. This was found to allow too much play and was thoroughly unsatisfactory. I believe there should be a difference in the drilling for 30- or 33-ft. rails and 60-ft. rails on account of expansion.

I approve of the standard dimensions given above, but would also approve of any other standard dimensions which should not vary materially from those given, and in which the relation between the size of the bolt and the drilling of the rail should be close to that given.

Mr. H. U. Wallace (Illinois Central—by letter) :—Our practice is the following spacing for bolts on all sizes of rail from 60-lb. to 85-lb.: 2 13-64 in., 4½ in. and 9 in., for long angle bars; 2 13-64 in., 4½ in. and 9 in., for short angle bars.

The drilling for 67-lb. rail and over is 1 1-32 in. diameter; under 67-lb. rail is ⅞ in. diameter.

I believe that 1 1-32 in. is the maximum drilling we should use, though I see no reason why we could not use one-inch. If the drilling is too close a fit for the bolt, there is no more danger of damaging the threads in putting on the bolts, while, on the other hand, if the drilling is too large, the bolt can not be as thoroughly tightened as it should be.

Mr. John V. Hanna (St. Louis & San Francisco—by letter) :—Taking up, first, definitions, I would suggest that better definition for a simple curve is the following:

"A curve the entire length of which is described without change of radius."

Referring to the matter of standard drilling for rails, I note the suggestion of steel rail manufacturers mentioned in the Committee's circular and would suggest that the standard spacing be made 2½ in., followed by some multiple of 4 inches. We have been using for the past two years a six-hole angle bar, the rail drilling being 2½ in., 4 in., 4 in. It has given very satisfactory results in use and our experience with it indicates that the closer spacing gives a better joint than a longer bar with the longer spacing, suggested by the manufacturers. It has, in addition to this advantage, the decided advantage of being shorter, therefore,

weighing less and costing less money. There is no reason why the same spacing could not be applied to a four-holed bar, or, in case a long splice to make a supported joint covering three ties is desired, spacing between the last holes can be made 8 in. instead of 4. What I wish to emphasize is that we get better results at less expense by using closer spacing than the manufacturers suggest.

Mr. W. C. Cushing (Pennsylvania Lines—by letter):—I would suggest substituting the following definitions for those given by the Committee:

Alinement.—The horizontal location of a railroad with reference to curves and tangents.

Curve.—A change in direction by means of one or more radii of given length.

Curve, Simple.—A change in direction by means of a radius of given length.

Superelevation (as applied to curves).—The amount which the outer rail is raised above the inner rail to counteract centrifugal force.

Line.—The comparative variation of the gauge line of the rails from a straight line of tangents and a true curved line on curves.

Compound Curve.—A curve consisting of two or more simple curves of different radii, all in the same direction, joining one another at point with common tangent.

Reverse Curve.—A curve consisting of two or more simple curves of the same or different radii, joining one another at point with common tangent, the curves at this common point being different in direction.

Level.—A condition of the track in which the tops of rails at right angle to lines of track are at the same elevation.

Taking up recommendations as to maintenance of line, adjustment of tangents. I think tangents should be thrown at summits as well as other points mentioned, if the least work is required thereby. No doubt any kinks in tangent should be put at summits, as they are less noticeable there. A great many roads have kinks in tangents, due to poor instrument work on location. To take them out may be very expensive, while a little lining to put them at summits may do away with the bad appearance and cost but little.

Mr. Chas. S. Churchill (Norfolk & Western—by letter):—Under the head of Proper Method of Spiking, article No. 3, the statement is made: "Under ordinary conditions it is not necessary to regauge such track when the increase in gauge has not amounted to more than ⅜ of an inch." I think that the Association in establishing rules and recommendations of this kind should err on the side of safety. I think, therefore, ⅜ in. is a little too large a margin. I would recommend that the figure be placed at ¼ in.

Under the head of "Methods used to prevent spreading of track and canting of rails on curves:" Item No. 1 of recommendations is certainly very secure in the line of safety, but, from actual experience, I think that it is not at all necessary to use tie-plates on all ties on curves in

case of heavy traffic. I think that item No. 1 should read: "For heavy traffic use tie-plates on all ties on curves of over 3 degrees." This would not only be perfectly safe, but would have a fair margin over actual requirements.

For medium traffic tie-plates at joints and on alternate ties on curves of 5 degrees and over would answer, or in lieu thereof rail braces. Our present practice is not to buy rail braces, but we are using our old rail braces on branch lines with light traffic.

For item No. 3 I would suggest that for *very* light traffic double spike the outside of rails.

Item No. 4 is certainly all right as it stands.

The above recommendations are made particularly with reference to roads that use oak ties. If the Committee have mentioned tie-plates in greater numbers purely on account of the use of soft ties, then the wording of the recommendations should be clearly made out to show that increased use of tie-plates is to be made on curves where ties of softer wood than oak is used.

Mr. F. S. Stevens (Philadelphia & Reading—by letter):—In regard to vertical curves I would say I do not consider that any fixed rule can be safely adopted, because a practice that would be permissible and quite proper on a road with heavy business would be sometimes extravagant and wasteful on a branch or unimportant line. I think, therefore, that an easy method that may be quickly applied and which will fit any case is the one to be desired.

As a rule, vertical curves are too short and are often more abrupt than even the most rigid economy in construction would make necessary. In good work the ratio should not exceed 0.05, and it will frequently be found an advantage to use still smaller figures. On important work the ratio may increase to 0.2 or even 0.3, if the grades are heavy and changes great. The length of curve and ratio of deflection to be used will therefore be a matter of judgment in each case.

On the subject of superelevation of curves, in my opinion the formula and table given by the Committee are not quite applicable, because the formula for centrifugal force does not strictly apply; no allowance being made for friction or the pull of the locomotives. Instead of a table, our practice is to use the middle ordinate of a chord equal in length to the distance usually run per second by our express trains. Thus we use actual, and not theoretical, conditions, and the formula becomes practically:

$$E = \frac{.85\ V^2\ G.}{32.2\ R.}$$

As to the maintenance of surface, line and gauge, will say that line and gauge depend on surface, and surface depends on drainage. If drainage is good and is properly maintained, the maintenance of surface is a comparatively easy matter; and if the surface is properly taken care of, the line and gauge will take care of themselves; thus the whole subject is practically covered by the question of drainage—the fundamental principle underlying the entire problem of efficient and economical maintenance of track.

Mr. Garrett Davis (Chicago, Rock Island & Pacific):—We did not accomplish as much as we hoped or would have liked to, but those of you who have served on committees know what it means to carry this work along in connection with your other work. You will find the conclusions and recommendations in the back of the report. There was some discussion or suggestions in regard to the change of definitions, which the Committee thought were very good and were willing to accept. The recommendations on standard drilling we would like to have the convention consider, because we think they are of considerable importance. We feel that with the adoption of the American Society's standard sections, which is pretty general and becoming more so, if we had standard drilling, the mills would make rails in large quantities in advance of orders, with the probability of finding sales for them and filling orders from stock material. The roads would also derive the benefit of being able to get rails on short notice, which is sometimes impossible now. The Committee do not assert this drilling is the best, but we believe it is as good as any. We had to agree on something, and we suggest this as a starting point. The matter of frog blocking you will find is recommended all over the country, and the Committee is very strongly in favor of it. To give credit where credit is due, I wish to state that the principal part of the report for 1903, which was not considered by the convention, was prepared by the chairman, Mr. W. B. Poland, and the historical part of the report was written by Mr. J. C. Sesser.

The President:—You have the report of the Track Committee before you. Shall we continue to discuss conclusions?

(On motion it was decided that the definitions be taken up first.)

The Secretary:—"Alinement.—The location of the road with reference to curves and tangents."

Mr. W. C. Cushing (Pennsylvania Lines):—I move that the following be substituted as a definition under "Alinement:" "The horizontal location of a railroad with reference to curves and tangents."

Mr. Davis:—The Committee accepts that.

The Secretary:—"Curve.—A series of changes in direction according to a regular method."

Mr. Cushing:—I make a suggestion with regard to "curve:" "A change in direction by means of one or more radii of given length."

Mr. Davis:—The Committee accepts that also.

The Secretary:—"Curve, Easement.—A curve of regularly varying radii, connecting a tangent to a simple curve, or connecting two simple curves."

(Adopted.)

The Secretary:—"Curve, Simple.—A series of uniform changes in direction according to a fixed method."

Mr. Davis:—The Committee will accept Mr. Cushing's suggestion on page 67.

The President:—Any discussion on the proposition to substitute Mr. Cushing's definition?

(The definition of Mr. Cushing on page 67 was adopted.)

The Secretary:—"Curve, Vertical.—A curve used to connect intersecting grade lines."

"Elevation (as applied to curves).—The amount which the outer rail is raised above the inner rail."

Mr. Cushing:—Under the head "Vertical Curve" I make the suggestion that the generally accepted term is super-elevation, and I move that it be so called, and that the definition be "the amount which the outer rail is raised above the inner rail to counteract centrifugal force."

Mr. Davis:—Super-elevation may be strictly correct, but it is not the term commonly used to refer to elevation of curves, and the Committee cannot accept that unless it is the choice of the convention.

Mr. D. MacPherson (Canadian Pacific):—I would like to ask the object of putting in the words "to counteract centrifugal force." These words may properly be used in explanation of the reason for elevating the outer rail on curves, but they surely do not form part of the definition of the word "elevation" or super-elevation (as applied to curves).

The President:—There is a motion to substitute the definition proposed by Mr. Cushing for that of the Committee, found on page 67. Discussion on that motion is in order. We would be glad to have the matter discussed.

Mr. E. C. Brown (Union Railroad):—As the chairman of the Committee says, the word "elevation" is in very common use, and it would seem to me that both terms ought to be defined.

Prof. W. D. Pence (Purdue University):—The word "super-elevation" is undoubtedly used by good authorities.

Mr. Cushing:—We use the word "elevation" to mean so many things in connection with plans, that the word "super-elevation," which is a distinct word by itself, should be used.

(The suggestion was not approved.)

The President:—The vote comes up now on the definition of the Committee, which is "elevation" (as applied to curves.)

(A vote was taken on the motion and the same was lost.)

The President:—The question is now on the original definition as submitted by the Committee.

Mr. A. S. Baldwin (Illinois Central):—I move that we add to Mr. Cushing's definition, "to counteract centrifugal force," making it read, "the amount which the outer rail is raised above the inner rail to counteract centrifugal force."

Mr. H. T. Porter (Bessemer & Lake Erie):—I think, as one of the Committee said, all we want to do is to define what the elevation is. Some of the roads use more elevation than others, with substantially the same speed. What we all want to know is what the elevation is.

Mr. J. C. Gray (Illinois Central):—I think it a good idea to add that. Occasionally a roadmaster's foreman picks up these pamphlets and reads them, and might inquire what centrifugal force is.

(The definition as submitted by the Committee was adopted.)

The Secretary:—"Gauge (of Track).—The shortest distance between

the inside of the heads of the two rails forming the track, the same to be measured between parallel surfaces, perpendicular to the plane through tops of the two rails, and projecting 1⅝ inches below this plane."

Mr. Camp:—This is a very important definition. It has been discussed for a long time, but has never been settled. If this Association can settle the matter, it will do something that is very much desired.

I do not agree with the Committee's recommendation as to the method of measuring the gauge. I think the gauge measurement should bear some relation to the gauge of the wheels and the manner in which the wheels make lateral contact with the rails. The location of the point on the wheel which makes lateral contact with the rail has been defined by the Master Car Builders' Association, and it has been used in car-building practice for some fifteen or eighteen years. The wheel makes lateral contact at the inside top corner of the rail, and I think the gauge should be measured between the top corners of the rail.

This question does not come up with rails of the American Society's standard, which have a head with vertical sides, but it does come up with rails with a sloping side on the head, and also with any kind of a rail which has been sideworn on a curve. Where the measurement is taken as recommended by the Committee, which is at the bottom corner of the head, virtually, there is extra play for the wheels which is not counted upon, and experience has shown that the closer you can get the gauge of the wheels, allowing for what is considered the necessary clearance, the steadier the cars will run. Roads formerly using a 4-foot 9-inch gauge have been gradually coming over to the standard gauge. The Pennsylvania Railroad is now gauging its passenger tracks standard gauge. The old standard of the Pennsylvania was 4 feet 9 inches. The tracks used exclusively for freight trains are still made wider gauge, but for fast speed it has been found that the gauge should be kept snug up to the standard.

I might take an illustration of the looseness which results by gauging rails between the bottom corners of the heads. Suppose we take the rails of the American Society's standard and lay them on a curve to standard gauge. In time the side of the outer rail or top corner will wear off, say half an inch. Clearly the gauge of the track has widened, because the wheels have more play than they did before; but, as measured according to the Committee's definition, the gauge would be the same as when the new rails were laid. Every bit of wear to the outside rail of a curve widens the gauge. I do not think that can be disputed on reasonable grounds.

It is not quite so convenient to measure gauge between the top corners as it is between the bottom corners. In order to measure it between the top corners it is necessary to have gauge lugs shorter than 1⅜ inches. On roads which have used rails with heads having a side slope there have been varieties of practice. Some of the roads have measured, as the Committee recommends, between the bottom corners; others between the top corners, and others have obviously wished to compromise

by striking an average and measuring at half the depth of the head. I think the proper way to measure the gauge is where the wheels make lateral contact—new wheels, we will say. After the wheels become worn, the gauge of the track is then relatively wider than before, and if the gauge is satisfactory for new wheels, it certainly cannot be too tight for wheels which have worn flanges.

Mr. F. S. Stevens (Philadelphia & Reading):—I think the ground taken by Mr. Camp is right, and that the proper point to place the gauge is at the bottom of the fillet radius of the wheel, which should be ⅝-inch. I make a motion that "⅝" be substituted for 1⅜, as proposed by the Committee.

Mr. Camp:—I agree with Mr. Stevens, except as to the dimension. The dimension of the M. C. B. Association is 17-64-inch up on the fillet above the tread of the wheel; ⅝-inch is the radius of the fillet, but the point of lateral contact is 17-64 above the tread.

Mr. Stevens:—I accept the amendment.

Mr. Camp:—That dimension has been ascertained by a very thorough series of experiments, so thorough that it would be unnecessary for this Association to go over the ground again. All the discussions which led up to the adoption of that dimension are on record in the proceedings of the M. C. B. Association, the gauge of the car wheels has been based on these dimensions, and I do not think we should be disposed to change them arbitrarily.

The President:—This will put us in line with the action of the M. C. B. Association, but will change our present practice.

Mr. Camp:—I do not understand that there is any regular present practice.

The President:—It is common for the gauge to be placed at a point about 1⅜-inches below the head of the rail.

Mr. Baldwin:—I believe this Association would make a serious mistake if it recommends projecting surface to be 17-64, or practically ¼-inch, below the surface of the top of the rails. When you regauge the track on curves, you would bring your rail in so you would have an extremely tight gauge, and the conditions are different with reference to the flange of the wheel from what they were before. On standard gauge with straight track, there is but the slightest bit of contact between the inner side of the rail and the flanges of the wheel. It is only the little inside corner radius that is playing against the rail, whereas, after the rail on a curve is worn, almost all the entire flange is bearing against the rail. If you bring the gauge of your rail in as far as it can be brought, with a projection of ¼-inch below the surface, you will have a tight track that will not be safe. I know it is a hard thing, with the standard gauge, unless you have an adjustment on the gauge, to keep the trackmen from getting it too tight. We have no practical experiments to show what effect it might have. It is a serious change, and before we vote on such a question as that, we should have some experiments and know our ground. I am not in favor of being in a hurry to vote on this question.

Mr. Camp:—I wish to ask Mr. Baldwin what he will do with the American Society section of rail, where there is a vertical side to the head. Do you not measure at the top corner of the head in that case?

Mr. Baldwin:—If you have a vertical side, yes, that is the gauge.

Mr. R. Trimble (Pennsylvania Lines):—I agree with Mr. Baldwin in what he has said in regard to the place where we should measure the gauge. If we accept Mr. Camp's amendment, we will have a lip on our track gauge ¼-inch in depth, and if we use that track gauge on such a rail as has been described by Mr. Baldwin—and you get the same kind of curve-worn rail in the American Society section as you do in other sections—the trackmen will have difficulty in getting the track to proper gauge, and if the trackman brings it in so as to get the rail in contact with the ¼-inch lip on the track gauge, he will have the flanges of the wheel riding on top of the rail.

Mr. W. B. Poland (Baltimore & Ohio Southwestern):—I believe if a worn curve track was put to standard gauge with a ¼-inch lip on the gauge, it would not only be undesirable, but positively dangerous. The specification for a 1⅜-inch projection on the track gauge was arrived at after a careful discussion by the Committee of a year ago, and after a study of sections of worn rails on curves, we put the 1⅜-inch projection in the specification for the purpose of bringing before the Association this very much disputed question of the point at which the gauge should be taken.

One of the considerations was the depth at which the flange of the wheel strikes on the rail, and I believe I am right in saying that the limit of wear of the flange, according to the M. C. B. Association rules, is 1⅜-inch. Now, if we gauge the track with a less depth of lug than 1⅜-inches, we will bring the contact of the flange against the side of the rail on the lower portion of the rim. Instead of the trucks being held to the center of the track by the crown in the tread of the wheel, they will be held to the center of the track by the bottom portion of the flange striking against the side of the head of the rail, and that will result in broken flanges. We do not have that action frequently on roads where there is much curved track and where the rail is allowed to become badly worn. It was after considering this point that the specification of 1⅜-inch was adopted.

As a maintenance proposition we would have to regauge our curves continually, whether the rails had actually moved or not. On curves of short radius it is not unusual to find a first wear of ¼-inch in a month. The track is just as safe, and possibly a little safer, for the traffic that goes over it after it is so worn, than when it was first laid new, assuming the rail has not canted or the base of the rail moved. If we should adopt the short lug we should have to regauge that rail ¼-inch, which would greatly increase our maintenance work and be opposed to safety rather than in its favor.

Mr. Camp:—The practice of widening of gauge of track on curves, spoken of by Mr. Trimble, is another question. I want to say that thousands of miles of track have been gauged in this way. For many

years the Lehigh Valley road used the Sayre rail, which had a sloping head, and the gauge was measured at the top corner of the rail where the curve begins to turn to make the corner, about ½-inch below top of rail. I want to repeat, on main roads the American Society rails are laid on curves to snug gauge. On some roads they even lay rails to snug gauge on sharp curves, but that is all foreign to the question we are discussing. If it is necessary to widen the gauge on curves, a certain allowance is made for that, but what we want to know by this definition is how to measure standard gauge wherever standard gauge is used, whether it be on tangent or on curve.

I say without fear of successful contradiction that when the side of the rail has been worn back ½-inch (or any supposable dimension), the track gauge is that much wider than it was previously. Suppose we draw the rail in that ½-inch, we have practically the same condition as before, notwithstanding that we have not the same shape of rail. It is true, of course, that when the side of the rail head is worn off to a slope, the flange makes contact from the fillet part way along the side of the flange, but when we measure to the top corner of the rail head we are measuring to a point where the fillet of the wheel makes contact; and while the flange of the wheel then runs nearer to the line of the bottom corner of the rail head than before, or perhaps even past that line, with respect to the outer side of the curve, it must be taken into consideration that the flange of the mating wheel, at the other end of the axle, is running just that much farther away from its rail; i. e., just as much further as the outer rail has been worn off at the side. If now either rail be moved in by the amount of the lateral wear, the original condition respecting the relative position of the wheel flanges to the rails is restored. As to the point that the wheel flange makes a larger area of contact against the side of the worn rail, that is true, of course; but since the flange slopes back from the rail to the same contour that the worn rail slopes from top to bottom corner, it is illogical to consider that point on the wheel to be on the same line with the point on the flange fillet which makes lateral contact with the top corner of the rail. Where Mr. Baldwin and Mr. Poland make their mistake is in considering that the flange fillet and the outer rim of the flange run on the same line or in the same plane respecting the point on the rail where the gauge is measured. If the gauge of the track is measured correctly for the fillet of the wheel flanges, it is utterly impossible to suppose that the flange of the wheel can be "right on top of the rail," as Mr. Trimble and the other gentlemen imagine.

Mr. MacPherson:—Taking as an extreme case ½-inch wear on the side of the rail head, and gauging that rail at ¼-inch below the top, the horizontal part of gauge will rest on outer top edge of rail, which may be ¼-inch higher than the inner top edge. If there is ½-inch worn off the side of rail head, there is possibly more than ¼-inch worn off the top inner edge, and it would be impossible to accurately gauge such track with a tool having only ¼-inch vertical lugs.

Mr. Camp:—The top of the rail will wear down as well as the side

of the head. But you will find that on curve-worn rails the inside top corners tend to wear away sharper rather than longer.

Mr. MacPherson:—The outer edge does not wear down as fast as the inner edge.

Mr. Camp:—You do not gauge the outer edge. You hold the gauge lug up to the inside of the rail at the top corner.

Mr. MacPherson:—Yes.

Mr. Camp:—That would be extreme carelessness, which I have never seen. I do not think any man would make the mistake of gauging to a point on top of the rail.

Mr. F. E. Abbott (Illinois Steel Company):—This is what may be called a theoretical gauge. It would apply to the standard sections without any harm to anyone, but if used on roads where the rails have beveled sides to the head, it makes a difference. I have in mind an important railroad which comes into Chicago, and which, according to someone's idea, changed the section of the rail. They were in line to use the standard section, but were required to change to the bevel-side rail, and it practically made them change the gauges throughout the whole length of track in which the new pattern was put in use.

Taking up the definition of gauge, we have the one stated by Mr. Camp, which would seem to cover that as a theoretical definition of the gauge. Further down in this report we see another gauge mentioned, where it refers to the tool. Adopting this theoretical definition of gauge would not limit the railroad to using any particular pattern of tool, but would settle what is understood by gauge and be applicable to both shapes of rails. The corner of the rail head on the standard sections is made on ¼-inch radius, and if you take the definition of Mr. Camp it would place the line of measurement directly at a point where the curve becomes tangent to side line of head. The same thing would apply practically to the rail with the beveled side.

Mr. G. A. Mountain (Canada Atlantic):—I wish to say a word in reference to some remarks Mr. Camp made. He stated that the flange of a wheel wore in the same portion as the rail wore. That would be correct, and the gauge suitable, if that is always the case, but you would be liable to run cars with new wheels, which had not worn, and get a tight track. We have a portion of fairly large curvature of track. With our consolidation engines the inside of the outside rail on curves wears very fast, and we change them over, and I must say I think it would be dangerous to place the gauge only ¼-inch down on top of the rail. We use the consolidation type of engine, 15-foot wheel base on 6-degree curves, and the innner side of the outer rail wears very badly.

Mr. Camp:—Do you widen the gauge?

Mr. Mountain:—Yes, but if we had narrowed it that ¼-inch, taking the gauge measure down ¼-inch, I think we would have a tight gauge.

Mr. Camp:—The question of widening gauge does not come in. We are speaking about gauging track. I did not refer to a track tool at all in my first remarks, but to the point where we should measure the gauge.

Mr. Baldwin:—The arrangement suggested by Mr. Abbott would make a theoretical gauge at variance with the track standard. They must be the same. There is one point which has not been brought out, and that is, by having the lip of the gauge 1⅝ inches below the top of the rail, you are absolutely on the safe side. You are certainly not going to get any gauge which will be dangerous by gauging in that way. It is possible on short curves to make the gauge too tight, but when you speak of the gauge of the track, you want to know exactly what the gauge is, and your theoretical gauge in this case must agree with your practical gauge. There is a possibility which you are bound to admit—that if you reduce these lips to 1¼-inch you draw your track in and you produce conditions which are dangerous; whereas, if the lip projects a sufficient amount to take in the outer part of the flange, you are not going to widen the gauge sufficiently to cause the slightest amount of danger, and you do avoid danger which would arise in bringing the rails too close.

Mr. Davis:—The ground has been covered pretty thoroughly. Mr. Poland stated the case in very good shape. The Committee considered that matter, and it was to get around precisely this matter of indefinite points on the sloping side of the rail that the lug on the gauge was intended to be 1⅝ inches deep, and the point of contact of the lug on the gauge is the point from which you want to measure on the rail, and so the definition is made correspondingly. The definition is that the measurement is to be made at the shortest distance between the rails, 1⅝ inches below the horizontal plane of the rail, and the gauge of the tools made accordingly. If you take an American Society section laid to gauge and the outside rail is worn off ½-inch, but the base of the rail has not moved, the track is to gauge and should not be moved in, and it is safer than if it was moved in.

Mr. Camp:—Then the wheels have more play than before?

Mr. Davis:—Yes, sir.

Mr. J. G. Sullivan (Canadian Pacific):—In reply to Mr. Baldwin's contention, I will say that in 1894 I was in charge of a section and had to do as the Chief Engineer told me. We put the track on 16-degree curves, to 4-foot 8½-inch gauge, put on with heavy tie-plates, and practically held the track where they were running the heaviest trains—perhaps the heaviest trains in the world—hauling ore, and we had very few derailments. It rather converted me from a wide-gauge advocate to a closer gauge advocate. Later, I have seen a track on a certain road, that I would not like to mention, that I think did not ride as well as it might simply on account of not enough care being given to the gauge of the track. That, of course, is neglect. But, if I am informed aright, the gauge of the wheels, as specified by the M. C. B., allows for play on a 4-foot 8½-inch gauge of track, and I cannot agree with anybody who claims that we will have a dangerous track, or that we will not have a smooth-riding track, if we spike our tangents to the 4-foot 8½-inch gauge, measured at the head of the rail.

There has been capital made out of the example that Mr. Camp brought up. To illustrate his case, he spoke of the wear on a curve.

If he had confined his discussion to the rail with a bevel side, I think that the convention would have gotten a better idea of his meaning, or the point he was trying to make.

The gentleman who spoke of the theoretical gauge, I think, is correct, because on curves we will widen the gauge anyway on sharp curves, and, therefore, if we have a special rail with a bevel side we will make our gauge to conform with that bevel, if we make it properly, and with the theoretical gauge the track will be measured at or about the point of contact, say ¼-inch from the top of the rail.

Mr. Trimble:—I would like to hear from Mr. Cushing on this matter. He has had practical experience on the Pennsylvania Lines with sharp curvature, where they have had well-worn rails on the outer rails of the curves, and I would like to know from him whether he would care to gauge his track at ¼-inch below the top of the rail on these worn rails?

Mr. Cushing:—As a general rule the trackmen are afraid of a wide gauge, and the tendency is to hold to the theoretical gauge as closely as possible. In making our allowances for the spread of the gauge on sharp curves, we are very conservative and insist on a very tight one. The trackmen themselves have a feeling against letting the gauge get wide, and the general tendency is not to drop the track gauges on curves where the gauge is not widened down to the full depth of the lug, but only to drop it from about ½ to ¾-inch, and I think that that is a very fair practice, but feel that the limit might be defined a little more accurately, as has already been suggested. I think the distance 1⅜ inches is too far down to measure the gauge of track on curves. I personally do not think it is necessary to spread the gauge on curves up to 6 degrees for such power as we are running. It requires the track to be well tie-plated in order to hold it, but I believe in holding it as rigidly as possible and keeping the gauge as tight as it can be kept with free movement of the wheels. In doing this I do not think that the limit of 1⅜ inches, as recommended by the Committee, is best.

Mr. Trimble:—Do you think ¼-inch is safe below the top?

Mr. Cushing:—My idea is not less than a half-inch, without going into the exact measurements of the wheel flange, because that has come to be the general practice of our trackmen from their standpoint of what looked to be a safe thing to do.

Mr. Abbott:—I think the thing resolves itself into just one question —is a guage 4 feet 8⅝ inches just as good as a gauge 4 feet 8½ inches? If engineers and maintenance of way men regard that as of no importance, there would be not much use changing this definition. If it is important, you are not guarding against it by adopting the definition, because you will get that ⅛-inch difference if you deal with this method of establishing the gauge.

The President:—The amendment is to substitute 17-64 for 1⅜ inches in the Committee's definition.

(The motion was lost.)

Mr. H. T. Porter (Bessemer & Lake Erie):—The point we want to

arrive at is how much below the rail the measurements should be taken. My experience has been that it is rather hard to determine where the sloping side on a badly worn rail and the top of the rail intersect. I have tried to get that information, and often wished that I had a section of the rail in the office on the draughting table. I think the common practice, as far as my experience goes, with the section foreman in gauging his track on curves where one rail is badly worn, is not to let the track gauge rest on top of the rail, but to block it up probably half the length of the lug; in other words, to let the projection below the top of the rail be in the neighborhood of ⅝-inch. If you leave the projection 1⅜ inches, assuming you want to get a certain gauge, you will get the gauge too wide. If you make your lug only ¼-inch deep, you will get it too tight, and my experience is that ⅝-inch is about the average distance below the rail at which it should be made, in order to get the relation of the wheels to the rail as nearly as you can the same as they were before the rail was worn.

The President:—Do I understand you to move to amend the definition by substituting ⅝ for 1⅜ inches?

Mr. Porter:—Yes.

Mr. Davis:—It was the idea of the Committee to avoid measuring on the sloping surface of the worn rail. We took the position that whether rail has vertical sides or not, if to gauge when put in, if the base has not moved, the track is not out of gauge; and if you measure it a year after it is put in, although the rails may be worn, if the base has not moved it is still in gauge. If the base does not move, the widening will not derail a car because of the worn rail, and the rail is safe under such conditions until it wears to interference with splices.

Mr. Porter:—We had a case of a 100-pound rail on tie-plates, and we allowed it to run probably longer than we are willing to allow it to run now, and the wear on the rail was not sufficient to materially weaken the rail, but it did make the gauge wider and allow a truck to move out on the outside rail so as to break off the head of the inside rail which had worn somewhat thin, causing a derailment. We are using rails on the inside of the curve that are not any thicker than those we had trouble with, but we keep drawing in our gauge as the outside rail wears. In those cases we took a number of measurements to see whether there had been a movement in the rail and we found that there had been no spreading due to the traffic, and that the tie-plates and ties had held the rails where they were in the first place.

The President:—The question is on the amendment to substitute ⅝-inch for 1⅜ inches in the definition of gauge.

Mr. Walter G. Berg (Lehigh Valley):—I offer an amendment to the amendment, namely, that the definition of rail gauge be referred back to Committee for further consideration and report next year, the Committee to take into consideration the remarks and views which have been brought out in the discussion at this convention and such further written discussions as may be presented.

The President:—The chair is of the opinion that this is the proper

action, but it is also desirable that valuable information should be brought out in a short time from members as to their practice, but the provision for written discussion will probably cover this, so that the amendment to the amendment will be put to vote.

(The amendment was adopted.)

The Secretary:—"Gauge (Track Tool):—Standard Specifications.—The gauge recommended shall be a wooden bar with parallel metal measuring surfaces fastened rigidily to it. These measuring surfaces shall be perpendicular to plane of top of rails and shall extend to a depth of 1⅝ inches below the same."

Mr. Tye:—That strikes me as hardly being a definition. It is a recommendation. What we are trying to get are definitions.

Mr. Camp:—Does not the term "standard specifications" require reference to another part of the report, to show its significance? It seems to me it is descriptive.

Mr. Davis:—This was intended to be what would be called a standard gauge, and while one gentleman says that it is descriptive, I do not know of any other way that you can express it, except by describing how the tool shall be made.

Mr. Tye:—I move that this definition be referred back to the Committee for action in connection with their definition as to gauge. The last part of this definition refers to the depth below the rail head, and it should be referred back with the other definition.

Mr. Davis:—The Committee would like some expression as to what is desired in this matter. If it is not plain, if it is not sufficiently descriptive, or if it is not the right kind of tool, we would like some expression as to your views of what would be desirable.

Mr. Baldwin:—This is a specification; it gives no definitions, and it is in the wrong place. We say in our specifications what would be a standard gauge.

Mr. Camp:—I understand that refers to the gauge as a tool.

The President:—Yes, the motion is to refer that back also to the Committee.

(The motion was carried.)

The Secretary:—"Level.—The condition of the track as to the equal elevation of the rails transversely."

Mr. W. McNab (Grand Trunk):—In these definitions we are aiming at conciseness, and without wanting to take away the full purport of the meaning given in the definition, I submit that the first seven words are hardly necessary in this case, and we would get the full meaning by simply stating, "Level.—The equal elevation of the rails transversely."

The President:—Do I understand you to move that, Mr. McNab?

Mr. McNab:—I move that the first seven words be stricken out.

Mr. Davis:—The Committee accepts that.

Mr. Poland:—I do not agree with that. This is a report of the Committee on Track. This is defining level as applied to track work, and as applied to track work the definition here given is that level is a *condition* of the track. There is some difference in ideas between saying

that it is an equal elevation of the rails and saying that it is a condition of the track.

The President:—The acceptance of the Committee is not binding on the Association, and if we want to overrule that acceptance we can do so.

Mr. Tye:—The definition says, "The condition of the track as to the equal elevation of the rails transversely;" if they were not of equal elevation transversely, how then? They would be badly out of level. Even if the words were left in, should not the words "as to" be changed? For my part, I agree with Mr. McNab that the first seven words should be cut out and make it as concise as possible.

Prof. G. F. Swain (Massachusetts Institute of Technology):—I ask whether it is necessary to have this word defined? Everybody knows what level means, and I do not see why it is necessary to bring it into the definitions.

Mr. Poland:—That is the reason I am saying I think the definition should stand as it is here. We all know what level is; we do not need a definition of that, but this is a definition as applied to the *condition* of a section of track on a railroad. We say the level of that piece of track is bad. What do we mean by that? We do not mean that one particular point is not exactly level, but we mean that the general condition of the track is good or bad, as to the equal elevation of one rail referred to the other.

The President:—It might be well for the members to read the definition of the word "surface."

Mr. McNab:—I submit that the definition of the word "level," as given here, by leaving out these seven words, will be in line with the general meaning of that word when used by any other Committee, and the full idea of the condition of the track in regard to level is got when it is said that it is the equal elevation of the rails.

Mr. Poland:—We do not want this to apply to every other level. We get that definition in the dictionaries. As Professor Swain says, we all know what level is. We are referring to level as understood in track parlance and to make definitions to cover the trackmen's talk.

Mr. Camp:—I think we need a definition of level, because the terms "level" and "surface" are sometimes confused. There is a distinction between "surface" and "level." An elevated curve track may be in surface, but out of level. I think we need the distinction.

Mr. J. V. Hanna (St. Louis & San Francisco):—I believe if we are going to leave the words in about the condition of the track, we should make it clear that we mean the rails are of equal elevation. It says, "The condition of the track as to equal elevation." I do not believe that states they are of equal elevation when they are level. I would move this amendment: "The condition of the track in which the elevation of the rails transversely is equal."

Mr. MacPherson:—If the level is bad, the elevations are not equal. If the level is good, they are equal.

Mr. Gray:—How will it be on curves? You do not speak of a track on curves being level—it is constant there.

Mr. Camp:—I beg to differ with the gentleman. We speak of track on curves as being in surface, but not in level.

The President:—The track can be level, yet badly out of surface.

Mr. Camp:—That is right, too.

Prof. W. D. Pence (Purdue University):—I ask if the word "elevation" is the same as "super-elevation?" Yesterday we used the term "super-elevation." The word "super-elevation" is used by the Committee on page 56. I presume it means the same thing as used above.

The President:—When the Committee refers to super-elevation, it means elevation of curve. It means "super-elevation" in using the word "elevation" in this definition.

(Mr. Hanna's amendment was adopted.)

The Secretary:—"Line.—The condition of the track in regard to uniformity in direction over short distances on tangents, or uniformity in variation in direction over short distances on curves."

Mr. Poland:—I suggest the adoption of the modification proposed by Mr. Cushing as follows: "The comparative variation" (and here I would insert three words, "over short distances") "of the gauge line of the rails from a straight line on tangents and a true curved line on curves."

(The amendment was not adopted.)

Mr. H. Rohwer (Missouri Pacific):—What does the Committee mean by short distances?

Mr. Davis:—The Committee gave this matter considerable attention and bore in mind what you call track in good line. You might have a swing a mile long, and yet the track will be called in good line—that is, would be in good line for short distances, not far enough apart to affect the movement of a train over it.

Mr. Rohwer:—If the engineers made a mistake in the location by not reversing the telescope, and there should be a break in the line, from one break to another break would be straight, and applying to the term "short distances." It is poor engineering, and no engineer would accept such a track for a good line. I think the term "short distances" should be eliminated.

The President:—The words are broadened to meet a condition and not a theory.

Mr. Poland:—The point brought out was intended to be covered by the distinction between "alinement" and "line." Alinement was intended to cover the point Mr. Rohwer brings up, and "line" was intended to cover what railroad men mean when they say to the section foreman, "Your line is bad on your section." They mean by that the variation from a true line over short distances. The section foreman is not responsible for putting in the transit line.

Mr. Cushing:—I would say a word in explanation of the definition which was proposed. I think the Committee's recommendation is too general. The word "line" as applied to track work is a very definite

thing. It is fine like a line. It is not the general uniform direction of the track at all; that is not what we mean by lining up the track. We are attempting to define that closer line to which the trackmen work—which is the gauge line of the rail, "the comparative variation of the gauge line of the rails from a straight line on tangents and a true curved line on curves." That is what the trackman means by "line." The definition given by the Committee is a sort of general defintion of a line such as these gentlemen on my left have criticised. If the definition were as I read it at first, those criticisms would hardly apply, but the objections apply to the general line for a railroad that is run through the country, and I do not think that is what we mean in this discussion.

Mr. Camp:—This term "line" is trackmen's phraseology. The engineer refers to "alinement," and by that he intends to cover either short or long distances. In considering this term we must inquire what the trackmen mean by it. They certainly refer to the condition of the track over short distances. One can take a long swing in the track and still get it so even that no jar will be noticed in the running of the trains. That is what the trackman means by "good line," exactly what the Committee stated here.

Mr. Baldwin:—I believe that the words "short distances" should be eliminated for this reason: This is a definition of a line. When you bring in the question of a variation from the line, either way, these are qualifying conditions and they do not affect what is a theoretical definition of line. For instance, in a line with a long swing in it, the trackman would say that the general line was bad, but he would say that the detail line was good. He would not say it in just that way, but that would be the idea. There are two kinds of line, the detail line and the general line. Both these words, "detail" and "general," qualify the word "line," and the word "line" is the one word we are now trying to define. I think the definition goes beyond its function when it includes these words "short distances," as suggested by Mr. Poland, and I move to strike out the words, "over short distances."

Mr. Davis:—This matter has been gone over very fully, but the Committee had in mind what you would say to a section foreman. If you told him to go to a certain milepost and line up the track, you would mean that there were two or three rails which needed lining up, and that is a condition which was intended to be covered by this definition.

Mr. J. G. Sullivan:—As engineers we are allowed to use "elevation" for "super-elevation." I do not see why we should not allow the trackman to do as he has done, and use the word "line" for "detail line."

Mr. F. J. Stimson (Grand Rapids & Indiana):—I think Mr. Baldwin's remarks are answered in the definition adopted yesterday of "alinement." That definition covers what he refers to as "general line," I believe. When we speak of the alinement on a tangent being poor, we mean there are swings in it; at the same time we might say that the section foreman has the track in good line, meaning that for short distances the rails are perfectly straight, and the same applies to curves when the rails follow a regular curve, so that I do not believe we are expressing

what we mean to express when we cut out the words "over short distances" in this definition. We have, as a convention, for the condition, which Mr. Baldwin suggests, of variations in long distances, adopted the term "alinement," and we are now trying to get a term which will define the other condition, which is the trackman's term for the condition of his track, having reference to the riding qualities.

Mr. Rohwer:—Alinement refers to the location of the line, whether there are curves in it or not. You ask the section foreman, after the engineer has done his duty and located a line, to retain that line. I think the section foreman should come up to that standard in his line; he should follow the one which the engineer has laid down on the ground, and if we allow him the privilege of this idea of "short distances," from one portion of rail to another, we leave out of sight the achievement of the engineer. I think the perfection of roadbed requires that the line should conform to the true line of tangent and curve, and we should not submit to the section foreman as to what he calls a good line. We should insist, after the location has been selected, that the lining of the track is in accordance with this alinement.

Mr. Cushing:—May I offer a substitute as an amendment?

The President:—Yes.

Mr. Cushing:—I offer the following: "The comparative variation of the gauge line of the rails from a straight line on tangents and a true curved line on curves.

The President:—That is the same definition we voted on a short time ago.

Mr. Cushing:—Mr. Poland, in recommending that, inserted the words "over a short distance," and that seems to be what is bothering the convention more than anything else—the words "over a short distance," and I omit those words from this amendment.

The President:—You have heard the amendment to the amendment.

Mr. Baldwin:—I do not accept that as an amendment.

Mr. MacPherson:—"Short distances" is indefinite, of course, but I do not see how the Committee could express it better. It seems to me the question is whether we will change the trackmen's meaning or whether we will adopt the trackmen's term at all. The Committee has expressed the meaning which the trackmen put upon that term, and I do not see how it could be made any more definite.

Mr. Baldwin:—The speakers keep on getting back to the section foreman. Suppose you had a piece of track with a swing in it, and you are not on the ground, and ask the section foreman if there is a good line on that tangent. He would say: "The line is not bad, but there is a swing in it." He would not fail to tell you, if you asked him about a tangent, that there is a swing in it. He knows the line is not good if it has a swing in it. If you fail to take out these words, "short distances," you are getting away from your definition of the word "line."

The President:—Any further discussion of the amendment to strike out the words "short distances" in two places in the definition of the Committee?

(The amendment was not adopted.)

The President:—The amendment is lost and the question is on the original definition as submitted.

(The definition was adopted.)

The Secretary:—"Surface:—The condition of the track as to vertical evenness or smoothness over short distances."

Mr. Poland:—I think exactly the same discussion applies to "short distances" in this definition as applied to the words "short distances" in the other definition.

The President:—It is practically the same question, and as the matter has been discussed I will put the motion on striking out the words "short distances" in the definition of "surface."

(The amendment was not adopted.)

The President:—The definition as submitted by the Committee is before you.

(The definition was adopted.)

The Secretary:—"Tangent—Straight track."

(Adopted.)

The Secretary:—"Track.—Ties, rails and fastenings, with all parts in their proper relative places."

Mr. J. G. Sullivan:—I think I got into hot water yesterday, or your Committee did, by going into "track" when we were talking about "ballast."

The President:—This definition seems to draw very clearly the distinction between track and ballast, and it is an important matter. Is there any discussion on the definition?

Mr. Hanna:—I believe, in view of the fact that the Board is considering the question of merging the two committees, an expression on the question of ballast is in order, and to bring out discussion I move the word "ballast" be inserted in the definition of "track" after the word "ties."

Mr. H. G. Kelley (Minneapolis & St. Louis):—If we were to accept that definition as amended what would we term track surfaced with earth? The definition as given by the Committee seems very clear and precise. We certainly have track without ballast. It may not be good track, but it is track nevertheless, and this would bring us back to the original action of the Association during its first years, where they outlined the duties of the Committee on Ballasting and the Committee on Track. They made a distinction at that time, and this definition agrees with that distinction. It appears to me the soundest definition that can be made.

Mr. Camp:—I once heard the question raised as to whether ties and rails laid and put together without surfacing is track. Laying track, as I understand, means putting these parts together and connecting them up, and it does not cover surfacing or ballasting the track. We ought to be very careful how we get that word "ballasting" in, because we might require some contractors to lay their track and ballast it before completing the work of tracklaying. I think the definition is clear, with possibly the exception that it ought to express whether or not these parts should be so connected as to make a complete structure.

The President:—The question is on the amendment to insert the word "ballast."

Mr. Edwin F. Wendt (Pittsburg & Lake Erie):—It has been suggested that the word "ballast" should not be included, because there is a large mileage of track built on trestles and bridges. There is no ballast there, and we all know that we do have track. It would seem to be inconsistent to include this word "ballast" and I would, therefore, vote "no."

(The amendment was not adopted.)

The President:—The question is now on the original definition. Are you ready for the question?

Mr. Berg:—I would like to ask whether the words "ties," "rails" and "fastenings" sufficiently designate it without further definition?

Mr. Davis:—The word "fastenings" was intended to mean bolts, splices, etc., in their relative positions.

(The definition as submitted was adopted.)

Prof. Swain:—The convention has taken great pains to secure precise definitions. I would like to call attention to two adopted yesterday, which, it seems to me, ought to be improved; the definitions for "curve" and "simple curve." I think the words "given length" ought to be stricken out. They add nothing, because, according to the definition a curve is not a curve unless the radii are given. I think the definition should be "curve—a change in direction by one or more radii" and "simple curve—a change in direction by a single radius."

The President:—Without going through the formality of a vote, we will take up the matter of definitions, as given by Mr. Cushing on page 67. The motion is to strike out the words "of given length."

Prof. Swain:—Does this cover both definitions?

The President:—Let it apply to both.

Prof. Swain:—"By means of single radius" should be added.

The President:—Is there any discussion on the amendment?

(It was moved and seconded to substitute the words "of one radius" in place of "single radii.")

The President:—Does the gentleman accept the amendment?

Prof. Swain:—I think "single" is better.

(The amendment was adopted.)

Mr. Cushing:—In order to complete the curve definitions, I think there should be two more, and I make the motion that they be adopted, as in the written discussion, "compound curve," and "reverse curve."

Mr. Davis:—The Committee accepts that.

The President:—As these words have not been presented in the original report, they will be voted on. Is there any discussion on the proposed definition of compound curve? The Secretary will read the proposed definitions.

The Secretary:—"Compound Curve.—A curve consisting of two or more simple curves of different radii, all in the same direction, joining one another at point with common tangent."

Mr. Tye:—The last part of it does not seem to be very clear, "joining one another at point with common tangent." If there were more than two they could not join at one point.

Mr. Cushing:—It is a misprint. It is either "a point" or "points;" whichever way the Committee wish will be acceptable to me.

The President:—It is understood that the amendment carries with it changing the word "point" to read "points."

Mr. J. G. Sullivan:—Mr. President, it does not appear clear to my mind. Where we would have two curves of different radii we would certainly have a compound curve. In fact, spiral is compound, changing its radius at every point. Will this definition cover that case?

Mr. Davis:—I think so. "Compound" or "spiral" is common to the same tangent at the ends or points of compounding.

(The definition as submitted, with the change in the word "point," was adopted.)

The Secretary:—"Reverse Curve.—A curve consisting of two or more simple curves of the same or different radii, joining one another at point with common tangent, the curves at this common point being different in direction."

Mr. Davis:—I want to make an amendment to that, and move to strike out the words "or more." You cannot have three reverse curves common to the same point. You can have two curves, but if you change your radii you have a compound curve. One may be compound and one simple.

Mr. Cushing:—We have cases where we have five, one after another.

Mr. Tye:—Yes, a reverse curve.

The President:—Does the gentleman moving the amendment accept the amendment to his amendment? The question is on the amendment to the amendment.

Mr. Poland:—I move that the words "the same or different radii" be stricken out. "A curve consisting of two curves joining one another at a point with common tangent."

The President:—It is moved and seconded that the words "curves of the same or different radii" be stricken out.

Mr. W. A. Hill (Mexican National Railway):—Am I in order to make an amendment to the amendment? If so, I would move that it read in this way: "A curve consisting of two curves in opposite directions, joining one another at a point with common tangents," making the second sentence combine the first.

The President:—That is hardly an amendment to the amendment, but it is a motion in lieu.

(A vote being taken, the amendment was carried.)

Mr. H. R. Safford (Illinois Central):—I move that the definition be changed to read, "An arrangement of curves or two curves."

The President:—The question will now come up in the form adopted, and you can amend that again. The Secretary will read the definition again.

The Secretary:—"Reverse Curve.—A curve consisting of two curves in opposite directions joining one another at common tangent."

Mr. Poland:—I move that the words "A curve consisting of" be stricken out.

(The motion was carried.)

Mr. F. H. McGuigan (Grand Trunk):—I think it will be necessary

to change the title in that case and say "reverse curves." You say a reverse curve is two curves.

Mr. Hanna:—I do not think it is necessary to make that change. A single line may have several changes in direction and still be one line, and a curve may be curved in opposite directions and still be one curve.

Mr. Berg:—"Curve" as originally stated in the definition is used the same as the second definition of the Committee report, where a curve is defined in general terms; and under special heads we have "curves," "simple curves." "vertical curves," "compound curves," "reverse curves." The term "curve" is used in a general sense in the original definition.

Mr. F. E. Schall (Lehigh Valley):—How do you account for a "Y", where two curves adjoin each other at a tangent?

Prof. Pence:—We can get around that by saying "a curve with two branches in opposite directions."

Mr. Hill:—It seems to me if we adopt that amendment, we will have to go back to the compound curve, using "continuous."

Mr. Camp:—We still have the "Y" to get around. If we would put in the word "continuous," we could make a definition that would not cover the construction of the "Y," which is contrary to the sense of the term we are aiming to define.

Prof. Swain:—If you go back to the definition of "curve" and put in the word "continuous," so that it reads "continuous change in direction by means of one or more radii," that would simplify it. The "Y" would not be a curve then.

The President:—After the word "two" put in the word "continuous."

Mr. Parkhurst:—I think we would add to our definition by saying, "a reverse curve is a curve consisting of two or more parts curving in opposite directions and joining each other at common points of tangency."

Mr. Camp:—The word "continuous" ought to be in there somewhere. It should perhaps read, "two curves in a continuous line, turning in opposite directions from a common tangent point."

The President:—As amended it would read as follows: "Two continuous curves in opposite directions joining one another at opposite tangent points."

Mr. C. A. Morse (Atchison, Topeka & Santa Fe):—I would suggest as an amendment "two curves in opposite directions, in a continuous line, joining at a common tangent."

Mr. Hanna:—The curve is a reverse curve because it is in a reverse direction from another curve. Either one of these curves is a reverse curve as related to the other curve. Therefore it seems incorrect to describe a single curve as two curves. Should we not define it as "a curve in a reverse direction to another curve which it joins at point with common tangent?"

Mr. Camp:—That might be a "Y".

The President:—The amendment of the gentleman on the left had no second.

Mr. Tye:—I second that.

Mr. Camp:—I accept the amendment.

The President:—The amendment is: "Reverse Curve.—Two curves in opposite directions in a continuous line joining at a common tangent point."

(The amendment was carried.)

The President:—The definition of "reverse curve" as adopted is substituted for that of the Committee.

Mr. Hill:—I move that we go back to the definition of "compound curve" and change it in conformity with the reading of "reverse curve."

The President:—The effect of that motion is already incorporated in the preceding.

Mr. McNab:—In order that the expressions used in this report for each of the definitions be more complete, I will suggest to the Committee that they define the word "fastenings" as used in the definition of the word "track."

The President:—Do you ask that they do that now?

Mr. McNab:—I make a motion to that effect.

Mr. Davis:—I do not like to go into details on that, because "fastenings," as ordinarily accepted, are understood to mean bolts, ties and splices. Some roads use one plate and some another; some one type of joint, and some another. One road might have a great variety.

Mr. Berg:—I think, owing to the vagueness and uncertainty as to what "fastenings" means and includes as used in defining "track," that it would be desirable to have the Committee make a definition of "fastenings." I do not think they ought to do so on the spur of the moment, but consider and report at another convention. In regard to the desirability of the term, aside from the question of its being used here to define the word "track," I would mention that I know of a case where relaying rail was sold and purchased on the basis of the term, so much rail with fastenings, and the question came up what was meant by "fastenings." In this instance it was understood verbally that it was splices and bolts. Therefore the term "fastenings" is used in business operations, and I think it would be well to have it definite and adopted after careful and due consideration.

Mr. Tye:—In the Interstate Commerce Commission's distribution of accounts, fastenings are there given, and I think a good definition could be found there.

Mr. Mountain:—Mr. Berg's discussion with reference to rails and fastenings is true. It is here stated "rails and fastenings." That would hardly be the full definition of "track." If you have ties, rails and fastenings, you must have spikes.

The President:—The motion before the convention is that the Committee give a definition of the word "fastenings" as used in their definition. Is it the pleasure of the convention that the Committee define the word "fastenings" as used in the definition of "track?"

(The motion was carried.)

The President:—The Committee is requested to define "fastenings," but is not prepared to do so now. We have completed the definitions, and will now proceed to the conclusions as submitted by the Committee. The first conclusion has practically been adopted—Bulletin 46, page 53.

The Secretary:—"Conclusion No. 2: That the recommendations under the headings of Maintenance of Line, Maintenance of Surface and Maintenance of Gauge of the 1903 report be approved."

The President:—These recommendations have been before the convention for three years, and they ought to be disposed of or relegated to the waste basket. We are proceeding under the motion to consider the report in detail, but the chair does not feel like taking up these three chapters in detail without the approval of the convention. The questions under discussion will be found on pages 56 to 62, inclusive.

Mr. Cushing:—I move the adoption of the first recommendation concerning Maintenance of Line.

Prof. Pence:—Ten lines from the top of (b) the word "super-elevation" is used. I do not wish to quibble over that word, but the Committee, to be consistent, ought to use the word "elevation" or "super-elevation," one or the other, all the way through.

The President:—The Committee proposes to substitute "elevation" for "super-elevation."

Mr. Stimson:—At the heading of "Maintenance of Line" they make recommendations for maintaining what I believe is defined as "alinement" and not at all as "line." A better heading would be "Alinement."

The President:—Is it not better to say "Maintenance of Line and Alinement?"

Mr. Stimson:—We do not maintain line in this method.

Mr. Gray:—In the definition "curve" is defined as "easement curve." I think it ought to be changed to "easement."

Mr. Camp:—I move that recommendation (b) read "Maintenance of Line and Alinement."

(The motion was carried.)

The President:—The motion is on the adoption of the matter relating to maintenance of line and alinement, on page 56.

Mr. Cushing:—I notice upon looking back to the summary of conclusions it says in 1902 the Association adopted their recommendations as to adjustment of tangents, adjustment of curves, etc. I wonder if we are throwing all that out now and starting over again.

The President:—The Committee states positively that that is a fact.

Mr. Poland:—It is my recollection that the report was referred back after being only partially discussed. I think you will find that the matter was referred back to the Committee for further consideration.

The President:—On page 77 of the Proceedings, section (b) as amended was carried. Does the convention care to consider that action further?

Mr. Cushing:—In view of that it would be proper for the Committee to explain why this is brought in now—whether they wish their former recommendation reversed, or what we are expected to do with it.

Mr. Davis:—I cannot answer directly on that. The Committee was unable to make a report last year, and this report was carried along as the report of the Committee. It was not expected that the convention would take up those parts of the report that had been acted on.

The President:—In other words, it was the will of the convention that we take this up, and it was an oversight that it had not been adopted previously. The Committee is anxious that the convention consider the matter of standard drilling in preference to other matters contained in the report.

Mr. Cushing:—I withdraw the motion I made on "alinement."

The President:—There is nothing before the house. At the request of the Committee we will take up the matter of standard drilling, found on page 44 of the conclusions. We will pass the second conclusion as having been already adopted by the Association at a former convention. The question is on conclusion No. 3.

Mr. Poland:—Am I to understand now, referring to conclusion No. 2, that the Association has approved the recommendations under Maintenance of Gauge, as outlined and recopied in this report for 1903? I believe it was shown that the recommendations under Maintenance of Line, as amended, did include alinement. Under Maintenance of Surface, am I to understand that that also has been approved, and that the balance of the report of 1903 has also been approved? That includes vertical curves and the proper methods of tamping, maintenance of gauge.

The President:—The chair is unable to state exactly.

Mr. Cushing:—My understanding of this now is that we adopted in 1902 recommendations concerning all of these points which are touched upon in this 1903 report; that we are declining to consider those questions again this year, because they have not been brought properly to our attention. We have already acted on those very matters, according to this statement. It was the duty of the Committee, if they had any changes to recommend, to plainly state so, in order that we might know how we stand, and be consistent.

Mr. Berg:—Mr. Cushing states my position exactly. I think the conclusions as embraced under the head of No. 2 should be received as information and referred back to the Committee. I make that motion, if it is in order. I do not wish, however, to cut off the consideration on such an important matter.

Mr. Poland:—There was a report submitted in 1902 on this subject, and it was dragged over two years without action being taken on it. I recall distinctly that we discussed this report and acted on it regarding section (b). I make a motion that we take up the consideration of this report, beginning at (c), and either accept the recommendations or turn them down.

Mr. Berg:—I consider that the chairman should make a positive statement how far the matter has been passed on heretofore.

The President:—The chair recollects distinctly that this matter of vertical curves was discussed and the entire report discussed down to (c). The preceding matter has been adopted. The proper order will be to take up question (c), on page 60, as moved by Mr. Poland.

Mr. Mountain:—Mr. Poland's contention is correct. He was the committee chairman in 1902, and all items down to (c), on page 60, were passed and adopted.

The President:—The Secretary will read the first clause of section (c).

The Secretary:—"(c) Proper Methods of Tamping: (1) Earth or Clay Ballast.—Recommendations: Tools: Shovel equipped with iron cuff or handle for tamping; broad pointed tamping bars. Work: Tamp each tie from 18 inches inside of the rail to end of tie with handle of shovel or tamping bar. If possible, tamp the end of the tie outside of rail first and let train pass over before tamping inside of rail; give special attention to tamping under the rail; tamp center of ties loosely with the blade of the shovel; the dirt or clay between the ties must be placed in layers and firmly packed with feet or otherwise, so that it will quickly shed the water; the earth must not be banked above the bottom of the ends of the ties; the filling between the ties must not touch the rail and should be as high as, or higher than, the top of the ties in the middle of the track."

Mr. Kelley:—In order to get the sense of the convention and expedite matters, I move that we adopt section (c) in its entirety.

The President:—Is it the desire of the convention that we discuss this matter in detail? The motion before the house is the adoption of it as a whole.

(The motion was carried.)

The President:—Maintenance of Gauge, page 62, is the next section of the report to be considered. The Secretary will read the same.

The Secretary:—"(4) Maintenance of Gauge.—(a) Proper Method of Spiking: (1) The gauge (tool) used shall be the standard gauge recommended."

"(2) When track is intended to be spiked to standard gauge, the rail shall be held against the gauge with a bar while the spike is being driven.

"(3) Within proper limits a slight variation of the gauge from standard is not seriously objectionable, provided the variation is uniform and constant over long distances. Under ordinary conditions it is not necessary to regauge such track when the increase in gauge has not amounted to more than three-eighths of an inch.

"(4) All spikes shall be started straight, and so driven that face of spike shall come in contact with base of rail; the spike should never have to be straightened while being driven.

"(5) Outside spikes of both rails shall be on the same side of the tie, and the inside spikes on the opposite side of the tie. The inside and outside spikes shall be separated as far apart as the face and character of the tie will permit. The ordinary practice shall be to drive the spike 2½ inches from the outer edge of the tie.

"(b) Allowance, if any, in gauge of curve, with consideration as to various practices. At the last convention it was suggested by your Committee on Track that a special committee be appointed to consider this jointly with the committee of the American Railway Master Mechanics' Association, and we still believe that this is the best method of procedure.

"The data which your Committee has collected during the year have shown widely varying results in different parts of the country. Some of the roads we find are flanging all tires and the road department is not

reporting trouble in holding the curves, while on other roads of lighter curvature, where tires have been flanged, great trouble has been experienced, both in the wearing of the rail and in the maintenance of gauge. We, therefore, do not feel at the present time that we are justified in making any report on this subject, but we hope to collect enough data to be able to justify conclusions later.

"(c) Methods used to prevent spreading of track and canting of rails on curves. Recommendations: (1) For heavy traffic, use tie-plates on all ties on curves.

"(2) For medium traffic, tie-plate all curves over 3 degrees.

"(3) For light traffic, double spike the outside of rails.

"(4) Tie-plates are recommended in preference to rail braces, except for guard rails and stock rails at switches, where the latter should be used."

Mr. Berg:—Ought not this whole paragraph (b), to be stricken out, not formally adopted?

The President:—It is argument, not a conclusion, and in voting on it we would not consider it adopted.

Mr. Wendt:—The Committee on Ballasting and the Committee on Track have used the terms "heavy traffic," "medium traffic" and "light traffic." It seems to me those terms are quite indefinite. Does the Committee mean a large volume of traffic, or does it mean heavy unit of loads on the axles? I think these terms should be defined more specifically.

Mr. Davis:—The Committee wish that each person determine that matter by the circumstances and conditions. It cannot be specific, so many millions of tons per year. Most roads have some heavy rolling stock but not all have large volume.

Mr. Camp:—The term "heavy traffic" has been defined by the International Railway Congress as "10,000 or more trains over a track in a year." The dividing line is between 27 and 28 trains per day over one track.

Mr. Tye:—I move that recommendation 1 be changed to read: "For heavy traffic, use tie-plates on all ties."

The President:—The motion has no second. All in favor of the adoption of the recommendation 1, paragraph (c), will say aye.

Mr. J. G. Sullivan:—I rise to a point of order. We are not discussing tangents; we are discussing the canting of rails on curves.

The President:—The point of order is not well taken.

Mr. Camp:—I would like to ask whether these recommendations will stand by themselves, or do they refer to (c) above that?

The President:—They refer to (c).

(The motion to adopt clause (1) was carried.)

The Secretary:—"(2) For medium traffic, tie-plate all curves over three degrees."

Mr. A. M. Shaw (Northern Illinois Electric Railway):—I suggest that the Committee recommend, first, the limit at which they would use curves and tie-plates, if they had hardwood ties on a certain degree of curve and soft ties on another degree of curve, giving the scales on

which they would use them, giving us a comparative statement of the desirability of tie-plates under different conditions of curvature and quality of ties.

The President:—I understand your motion is equivalent to referring this particular recommendation back to the Committee.

Mr. Shaw:—That would be my idea, taking into consideration the quality of the ties and allowing flexibility, so that each road can decide for itself as to when they will begin using tie-plates, showing in their recommendation points where they think tie-plates absolutely necessary.

Mr. Kelley:—I am not opposing that motion, but I wish to call attention to the fact that a statement of that kind must consider the base of the different rails as to their effect in cutting the ties. If we have a certain tonnage passing over a division laid with 60-pound rails, the necessity for tie-plates should be greater than if it were laid with 80-pound rails.

Mr. MacPherson:—In giving the Committee such instructions as that you would be giving us a great deal of detail work which it would be almost impossible for us to do, and work which it is proper to expect should be done by the individual railroads.

Mr. C. S. Churchill (Norfolk & Western):—As against the amendment, I refer to the heading of the paragraph, which reads, "Methods used to prevent the spreading of track and canting of rails on curves;" this indicates that the use of tie-plates for this purpose is independent of the degree of hardness of the tie. Of course, the rails will cant a little more rapidly on the soft tie than on the hard tie, but they will cant in a comparatively short time on the hardest tie. Therefore, I consider it would be an error to refer this back to the Committee. I think we are in shape to vote on it.

Mr. E. C. Brown (Union Railroad):—It seems to me that this recommendation might be a little more general than is indicated by signifying a curve of certain degrees.

The President:—I will ask the gentleman to confine his remarks to the motion to refer this back to the Committee. Are you speaking to that motion?

Mr. E. C. Brown:—Along that line. I object to throwing that back on the Committee. As has been expressed by Mr. Kelley, I think the result would be too complicated a statement for practical use.

(The motion to refer back to the Committee was lost.)

The President:—The question is on the original paragraph, which reads as follows: "(2) For medium traffic, tie-plate all curves over three degrees."

Mr. E. C. Brown:—Now perhaps my remarks will be more pertinent. It seems to me to specify three degrees is a little bit too restricted for general use.

The President:—Do you move to amend that paragraph?

Mr. E. C. Brown:—I do not know that I would be competent to offer an amendment, but that is my idea. Perhaps someone else can couch the idea in better language.

Mr. Kelley:—Four years ago this very question came up on the line with which I am connected. It rose upon divisions where we used exclusively cedar ties, except at the joints, quarters and centers, and we commenced the application of tie-plates in a tentative way. We were having difficulty in keeping the track in shape and the rails from canting, which was becoming excessive, and we applied tie-plates on curves of four degrees, with an immediate reduction of expense of maintenance. We still noticed that curves of three degrees and sharper required unusual attention, but curves of one and two degrees which, under the traffic passing over the division, did not require unusual attention. The next year we applied tie-plates on all curves of three degrees and over. The tonnage remained about the same on the division, and for two years this division has been maintained without the addition of more tie-plates, and the amount of track work required to keep the rails from canting is trifling. So that our experience appears to bear out the judgment of the Committee on this recommendation very closely.

Mr. Stimson:—It seems to me, inasmuch as the term "medium traffic" is relative, that in this recommendation there should be some elasticity, and I would move that it be amended to read "for medium traffic, tie-plate all curves where the conditions require them."

Mr. Poland—Somewhat in line with Mr. Stimson's remarks, and anticipating the action of the convention as to paragraphs 3 and 4, so that the idea may be seen in advance, I will state that, providing these recommendations (1), (2), (3) and (4) are approved by the Association, I would suggest that we add a fifth recommendation to these, to the effect that recommendations (1), (2), (3) and (4) are given as general rules, but that they must be applied with the following understanding—and this I take as an extract from the rules of the Pennsylvania Railroad applying to tie-plates, which it seems to me are exceedingly well stated. The fifth recommendation would be as follows: "Tie-plates must be used wherever ties wear out faster than they fail by ordinary decay; on softwood bridge ties; on curves instead of rail braces; where rail shows a tendency to turn or spread, such as sharp curves, switch leads, etc.; on switch ties in yards and switch leads with heavy switching service; on road-crossing ties; and on track subjected to heavy service wear, by respiking, adzing and by the sawing and cutting action of the rail, where ties wear out before they decay." I think such a recommendation as that added to the others, and interpreting the application of the others would be advisable, and I believe would cover Mr. Stimson's amendment that tie-plates be used on three-degree curves where the conditions make it necessary.

The President:—Will Mr. Stimson withdraw his amendment, with the anticipation of being able to apply at the end of the matter with a fifth clause as outlined by Mr. Poland?

Mr. Stimson:—It still seems to me, with the term "medium traffic" in there, you cannot fasten yourself to any definite degree of curve, as the term "medium traffic" is elastic, and the point at which you will need the tie-plates will vary with the traffic. I am connected with a road having

what would be considered medium traffic, and we find that we need tie-plates on two-degree curves to prevent canting and spreading of the rails. We do not use them on all two-degree curves, as on portions of our road the traffic is lighter. We do not use them on all two-degree curves, for the further reason that on some of these curves we use all hard ties, and we do not consider them necessary. "Traffic," as defined here, varies, and the conditions that require tie-plates will vary, and for the convention to say that it is a three-degree curve which requires tie-plates is not correct. I do believe there are not many trackmen here who are willing to say that they will stop at three-degree curves. They will put the tie-plates on two-degree curves, or one-degree curves, if the general conditions require them, and I might say, as long as the convention wishes to make some fixed recommendation, that if a one-degree curve is specified, that might be nearer the right thing to say than "where conditions require it."

Mr. Davis:—Mr. Stimson says to put the tie-plates on all curves having medium traffic, where conditions require it. Why say anything about medium traffic, or why say anything about the degree of the curves?

Mr. Stimson:—I would leave out the three degrees.

Mr. Davis:—"Medium traffic" also?

Mr. Stimson:—It resolves itself down to that.

Mr. Davis:—Why not be broad enough and say to use tie-plates where the traffic requires them? If you have light traffic over three-degree curves, with soft ties, you will not tie-plate them.

Mr. Stimson:—Why do you say double spike?

Mr. Davis:—We have tried to be specific, and the matter of traffic is independent, and that must be determined by each road for itself. One gentleman asked the Committee to be more specific, and said that we lay down exact limits; another gentleman says that we are too specific.

Mr. Baldwin:—I think the matter read by Mr. Poland is good, but I think it properly comes under the consideration of the Committee on Ties. It is, of course, pertinent to the point mentioned in this report relating to the spreading of track and canting of rails on curves. The conditions are so varied which are attempted to be covered by these four specifications, that to cover them properly would involve an amount of detail that it would be practically impossible for the Committee to deal with. They must first consider the amount of the traffic, the weight of machinery, the degree of the curves and the character of the ties. I believe that a general recommendation such as is suggested by Mr. Stimson would better answer it than any attempt to go into details which would be voluminous. Instead of the heading "(c) Methods used to prevent spreading of track and canting of rails on curves," I suggest the substitution of "(c) The use of tie-plates when necessary in preference to rail braces." I move to substitute that for the recommendations.

Mr. Tye:—The Committee must be either much more general or much more specific. They are neither one nor the other. I move that the convention reconsider recommendation No. 1, which has already been adopted.

(The motion was lost.)

The President:—The question is on the amendment of Mr. Stimson to paragraph 2.

(The amendment was lost.)

The President:—The question is on the adoption of the paragraph (2) as it stands.

(Adopted.)

The Secretary:—"(3) For light traffic, double spike the outside of rails."

Mr. Tye:—Here is another instance where the Committee is not specific enough. For light traffic on sharp curvature, they suggest nothing but double-spiking the outside rail. On the Pacific Coast, where the curves are sharp, as sharp as ten and twelve degrees, and sharper, for light traffic, are common. Would they do nothing more than double-spike the outside rail on a 12 or 14 degree curve? I do not think they would maintain their track very long.

Mr. Kelley:—In discussing some of these questions, are we not losing sight of the fact that the Proceedings of this Association are referred to as books of reference, as a guide to practice? If someone not a member of the Association should refer to the report of the Committee on Track for guidance as to what he should do in the matter of the application of tie-plates, and he is met with a paragraph which says "Use tie-plates where necessary," he is as ignorant as he was before. The Committee, having corresponded with many of the members of the Association, and being trackmen themselves, have said under ordinary conditions they would recommend as follows—and then follow the recommendations. That is a guide to anyone referring to the Proceedings for the recommendations. Therefore, if we adopt the recommendations of the Committee, we have given a guide to everyone. We can qualify these recommendations with another recommendation like that suggested by Mr. Poland, and it would appear to me that by doing so we would entirely cover the ground in a consistent, logical and sensible manner.

The President:—The shortest way to do that would be to adopt the paragraphs as they are presented and then add another.

(Paragraph 3 was adopted.)

The Secretary:—"(4) Tie-plates are recommended in preference to rail braces, except for guard rails and stock rails at switches, where the latter should be used."

Mr. Camp:—Where the track is shimmed in winter it is important to brace the rail, and it seems to me that point should be covered. I make a motion that tie-plates be recommended in preference to rail braces, except for guard rails, stock rails at switches, and on shimmed track, where the latter should be used.

Mr. Shaw:—I think the Committee, to be consistent, should cover such a point as that in the general item to follow, and it would be well not to specify that in this particular paragraph.

The President:—It is pretty well understood that we are going to limit the application of all of these.

Mr. Kelley:—We are endeavoring to formulate an addition that would

apply to the use of tie-plates, not only on curves, as covered by the recommendations of the Committee, but on tangents. Mr. Poland suggests that it is rather difficult to frame the addition.

Mr. Poland:—Would it not be in order to recommend to the Committee that they consider the subject of tie-plates and their application in preventing the spreading and canting of rails on curves, and also the economy of their use, and report their conclusions to the convention next year? It is possible that question should go to the Tie Committee, and probably that is a case where the two committees overlap and in which the action should be joint. The subject of tie-plates seems to be properly under the Track Committee. It is essentially a track device, and in that sense should be considered by the Tie Committee. So that, for the purpose of discussion, I will make a motion that the Track Committee confer with the Tie Committee and submit at the next annual convention their recommendations as to the use of tie-plates and their applications for the purpose of preventing the spreading of the track and the canting of the rails on curves.

Mr. Kelley:—I supported Mr. Poland's motion to make an addition to these recommendations, but I think we should consider another feature. Certain members of the convention assembled have passed these various articles on the supposition that this general clause would be enacted before this Committee was discharged, and in making my previous remarks I had no desire to lead the members into a trap. If Mr. Poland will allow the Committee to take the Pennsylvania Railroad track rules, I believe that in a few minutes they will formulate a clause which they are willing to recommend.

The President:—There is no objection to the course which Mr. Poland proposes, except that a large number of members were led to vote for the four paragraphs which have been adopted with the understanding that such an amendment of a general nature would be brought in. Those members who voted for it have the privilege of bringing it in.

Mr. Poland:—We will get the matter in shape and present it.

Mr. Kelley:—I have here a general item in reference to the use of tie-plates on curves to be included in the Committee's recommendations as item 5 under paragraph (c). I have submitted this to the gentlemen who made objection to item 3, and others, and also to the Committee. The Committee has agreed to accept it if it meets the sense of the convention. I therefore move that we add a clause to paragraph (c), making it No. 5, to read as follows: "Tie-plates should be applied in all cases where greater economy in maintenance is secured by their use than in depending on the life of the tie limited by rail wear."

(The clause was adopted.)

The President:—We will now take up the matter of standard drilling for rails. This will be found on page 53, of Bulletin 46, third paragraph.

The Secretary:—"(3) That the standard drilling for rails be as follows:

End of rail to center first hole.....2 13-32 in.
Center of first hole to center of second hole....5 in.
Center second hole to center third hole.....5 in.

"Diameter of hole in rail to be 3-16 in. larger than diameter of bolt used.

"The punching in splices to be alternately oblong and round, to permit staggering bolts in rail, high enough to allow it without flange interference. The round hole (diameter) to be 1-16 in. larger than the diameter of bolts over thread."

The President:—I believe Mr. Webster has a statement to make in reference to this matter of standard drilling.

Mr. William R. Webster (Consulting and Inspecting Engineer):—The only statement I had to make I made yesterday in connection with the report of the Committee on Rail, that is, that we wanted a discussion of this subject, as we did not feel ready to recommend any standard drilling at this time.

Mr. J. A. Atwood (Pittsburg & Lake Erie):—I ask the Committee if they intended that this recommendation shall carry with it the proposition of its use for a six-hole anglebar as a standard?

Mr. Davis:—The Committee leaves that optional. We understand that some of the members are in favor of four holes and others are in favor of six holes, but we do recommend that the rails shall be drilled that way.

Mr. Atwood:—I would object to this drilling if it is to be applied to a four-hole anglebar. I think the distance of 15 inches, center to center of the outside holes, is not sufficient for the proper maintenance of the rail joint. It will not allow the ties to be spaced sufficiently far apart so that the joint ties can be properly tamped. I therefore think that the outer holes of the anglebar should be 18 inches apart instead of 15 inches, for the purpose of allowing us to space the ties far enough apart to get at them to properly tamp them. The ties must be spaced so that the slot for the spike on the joint ties shall come into proper position on the tie. That cannot be done with the diagram which is submitted.

Mr. Hanna:—I would say in that connection that we have had in actual use a great many splices, with these spaces, 5 inches for the holes in the anglebars, and we have not had any practical difficulty about adjusting the slots.

Mr. Atwood:—We are in the same position also in that respect, we have used such anglebars, but it is my belief that you cannot get the greatest good from a splicebar where the drilling for a four-hole anglebar are such as is indicated here. I believe that the ties must be spaced further apart than 7 or 8 inches, as indicated here, in order to allow you to properly tamp the tie. In order to bring this point before the convention I would move that the recommendation of the Committee apply only to six-hole anglebars.

Mr. Wendt:—I would like to get an expression from the Committee describing the basis on which they proceeded in designing this joint. They have allowed 8-inch spacing between the ties, or 16 inches from center to center of ties. Does the Committee consider that 8 inches between the ties is sufficient distance to permit proper tamping? They

also have designed a joint with reference to a tie 8 inches in width, while in many parts of our country 9-inch ties are very generally used, and they are hewn ties also. I ask for information, because we cannot design a proper length of joint unless you first assume what the distance between ties is to be.

Mr. Davis:—The Committee assumes that 8 inches in the clear between the ties, 16 inches on center, is ample clearance to permit proper tamping. If you have wider ties than that you cannot space 16 inches on centers and get the clearance. You get the same result by making 8 inches in the clear between them.

The President:—The question is on the motion to make the recommendation of the Committee apply to six-hole anglebars only.

(The motion was lost. The paragraph as submitted by the Committee was adopted.)

The Secretary:—"(4) That the heel of all frogs be made with a steel filler block, to fit the section of rail securely bolted in, with the outer end of filler planed off ⅜ in. below top of rail, to act as a riser for the outer edge of worn treads.

The President:—As this conclusion No. 4 is a matter that involves a great deal, I think we had better consider it separately.

(Conclusion No. 4 was adopted.)

The Secretary:—"(5) That the wings and throat of all frogs be blocked with a metal or wood blocking, shaped to fit rail-section; give 1½ in. flange clearance, and securely bolted to frog."

(Conclusion No. 5 was adopted.)

Mr. D. MacPherson (Canadian Pacific—by letter):—On page 69 of Bulletin 46, Mr. F. S. Stevens adversely criticises the Track Committee's proposed formula for superelevation of outer rail on curves, because, he states, "No allowance is made therein for friction, or the pull of the locomotive."

He further states that his practice is, "Instead of a table, to use the middle ordinate of a chord, equal in length to the distance usually run per second, by our express trains." Thus he claims to get actual, not theoretical, conditions. It will surely be admitted by everybody that he does not thus get theoretical conditions, but none the less surely does there seem absence of proof that this forms any actual or true basis for a rule by which to elevate the outer rail.

All maintenance of way men will agree that if we had only one definite speed to elevate for, we should have no difficulty in putting up our curves in good shape and keeping them so; and the theoretical formula would, in such a case, be found to apply very closely indeed. If it applies closely for any definite speed, surely it must be the best foundation to start from. The extent to which it should be modified to suit varying speeds, and different classes of trains on a single line, must, of necessity, be a matter of judgment. It is not clear to me how Mr. Stevens gets his allowance for friction and pull of the locomotive, the absence of

which is complained of, by the simple method of taking the middle ordinate of a chord.

I trust he will kindly shed some light on this point.

Mr. F. S. Stevens (Philadelphia & Reading—by letter):—Referring to Mr. MacPherson's comments on my remarks published in Bulletin No. 46, on the recommendation of the Committee on Track, that the formula for centrifugal force be used to determine the proper super-elevation of the outer rail of curves in railroad tracks, I beg to say that the formula for centrifugal force:

$$C = \frac{W V^2}{32.16\, r}$$ in which

C = centrifugal force,
W = weight,
v = velocity in feet per second,
r = radius of curvature,
32.16 = acceleration due to gravity,

is applicable to bodies moving freely through space. In its application to bodies moving on parallel rails, the gauge of track and the height of the center of gravity above the rails must be considered, and the formula must be changed to meet the conditions. We have two forces to deal with, and the object of the super-elevation of the outer rail is to place these forces in equilibrium, thus neutralizing both, and securing thereby the same conditions as to pressure (or weight) on the rails that we have when trains are moving on straight and level track.

To accomplish this it follows that, as the sine of the angle between the verticals let fall from the center of gravity when the car is on straight and level track, and when it is on the curve, multiplied by the load, must equal the centrifugal force; then the sine of this angle, multiplied by the gauge, will give the proper super-elevation of the outer rail for cars moving by gravity and with the center of gravity of the load at right angles to, and directly over, the center of the track, on this right angle line.

The formula then becomes:

$$E = \frac{V^2 g}{32.16\, r}$$ in which

E = super-elevation of outer rail,
V = velocity in feet per second,
g = gauge of track,
r = radius of curvature,
32.16 = acceleration due to gravity.

These are not the conditions, however, that must be generally provided for. Trains are hauled by the locomotive; and cars, in passing around curves, make more or less of an angle with each other; and the pull of the locomotive, multiplied by the resultant obtained from the parallelogram of forces, must be subtracted from the centrifugal force to be

overcome. Thus it follows that the head end of a train does not require so much super-elevation of the outer rail as does the rear end, and that a compromise on this account, as well as for varying speeds of trains, is desirable.

It is evident, from the above, that, as the radius of curvature diminishes, the action of the locomotive in neutralizing centrifugal force will increase, and therefore none of the formulas now in use are strictly correct; and this is particularly true as applied to roads having light grades, and long and sharp curves, and handling long and heavy, as well as fast, trains of all classes.

By using the middle ordinate of the chord, equal in length to the number of feet ordinarily run per second by express trains around each curve, as determined by frequent observations taken by Division Engineers and Supervisors, we are able to get a compromise adjustment of super-elevation to speed that fits the actual conditions in each case, and appears to make proper allowance for the loss of centrifugal force due to the pull of the engine and other causes. It also furnishes the Track Foremen with all the data they need for the proper adjustment of super-elevation to curvature on spirals and compound curves, and curves of uncertain radius. The use of the chord also shows the Foremen where curves need readjustment, and what must be done to restore them to proper line.

The trouble found in the treatment of this subject is generally caused by assuming too much, and observing and investigating too little. It is not sufficient to know that one or two trains reach high speeds at some points on their run; the usual speed maintained around each curve should be known, and each curve should be treated accordingly; and the chord-length as determined by the speed appears to fit the case.

Mr. F. P. Gutelius (Canadian Pacific Railway—by letter):—In the matter of shovel tamping, the Committee, under Section 3, Maintenance of Surface, recommends that shovels for tamping be "equipped with iron cuff or handle for tamping."

Some years ago this idea suggested itself to the writer when ballasting a yard with cinders. The workmen were ordered accordingly to tamp with the shovel handles. In a short time it was noticed that the blade of the shovel was cutting the hands of the workmen, and, on account of this method of tamping being impracticable, the practice was abandoned.

It is suggested, therefore, that the words "equipped with iron cuff or handle for tamping" be eliminated from the recommendation.

Mr. W. M. Camp (Railway and Engineering Review—by letter):—The recommendation of the Committee that shovels for track ballasted with earth or clay be "equipped with iron cuff or handle for tamping" is, I think, a point well taken, and the same recommendation should apply to shovels for track ballasted with sand.

My experience has been that where the iron cuff or "D-tip" is not provided for shovels used in ballast of these kinds, the workmen will use

the wooden tip or handle part of the shovel for tamping, just the same, and such treatment will soon wear the handle out or cause it to swell and burst the rivets from moisture absorbed when the ballast happens to be in damp or wet condition.

In sand or dirt ballast the blade of a shovel is not a good instrument for tamping, owing to the finely divided character of the material. About all that can be done with the shovel blade in such material is to fill the space under the tie, without packing it. For this reason the inclination of the workman is to grasp the shovel blade in his hands and ram the material a few times with the shovel handle before leaving the tie, in order to pack the material more firmly in place. The iron cuff is therefore serviceable, and it enables the tamper to work the tool under the tie, directly beneath the rail, to much better advantage than could be done with the shovel blade. In any case it protects the shovel handle from breakage or from such unusual wear as might result from occasional use of the handle as a tamping instrument, even where such use is not ordered or authorized.

I think the observations of Mr. Gutelius regarding the use of shovels equipped with iron cuffs, in cinder ballast, are quite correct. He states that the workmen were ordered to tamp such material with the shovel handles, and it was found that the use of the shovels in this way cut their hands; and this method of tamping was abandoned for that reason.

It is quite true that the use of shovels in this manner is severe on the hands of the workmen, in any kind of ballast; and even in such soft material as earth or sand the workmen will not from choice use their shovel handles for tamping all of the time. The inclination is to use the shovel handle for a tamper more for a change than as a steady habit, giving the ballast a few jabs with the end of the handle to put on the "finishing touches," when about to leave the tie. It could not be expected to use the shovel in this way all the while, as the blade would cut the hands of the workmen, as Mr. Gutelius has stated.

For working gravel or cinder ballast the iron tip or cuff on the shovel handle is not needed. In such material the particles of ballast are large enough to be caught on the edge of the shovel blade, so that the latter can act as a rammer, or in some degree similar to the action of a tamping bar. Such being the case, it is rarely, if ever, that the idea of using the shovel handle for tamping in such material will occur to a workman, and the wooden handles of shovels are not nearly so liable to abusive use as is the case when shovel tamping is done in earth or sand ballast.

Mr. Jos. T. Richards (Pennsylvania—by letter):—We are entirely convinced that the spacing of bolt holes at 2 in., 5 in. and 6 in. is about correct, and that we must use a one-inch bolt. It would therefore be necessary to have a 1⅛-in. hole through rail instead of the 1-in. suggested. This refers to 85 and 100 lb. sections, but a one-inch hole for lighter sections would be sufficient.

Some years ago we tried to change drilling of rails, but found we would have to carry a large stock on hand in order to introduce the splices drilled differently from those in track, so abandoned the idea. We would have to show a very decided gain, commercially, to induce them to go to the trouble of changing drilling of their rails.

COMMITTEE NO. XV—IRON AND STEEL STRUCTURES.

To the Members of the American Railway Engineering and Maintenance of Way Association:

Acting under advice from President McDonald, your Committee has not prepared a formal report of its work during the past year for presentation at the annual meeting; but the following table of upsets for screw ends of round and square bars has been prepared at the request of manufacturers, and is submitted for the consideration of the Association. It is hoped that the table or some modification of it will be approved by the members, so that a uniform standard of upsets will be available for all those who have use for such information.

STANDARD UPSETS.

For Round and Square Bars.

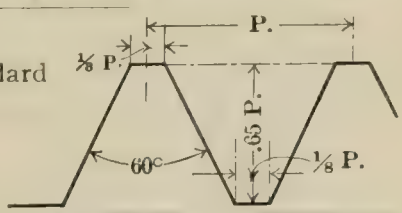
ROUND ⊙ BARS.

Bar.	Upset.		Bar.	Upset.	
Diam. Inches.	Diam. Inches.	Length Inches.	Diam. Inches.	Diam. Inches.	Length Inches.
3/4	1	4	2 1/2	3	6
7/8	1 1/8	4	2 5/8	3 1/8	6 1/2
1	1 3/8	4	2 3/4	3 1/4	6 1/2
1 1/8	1 1/2	4	2 7/8	3 3/8	7
1 1/4	1 5/8	4 1/2	3	3 1/2	7
1 3/8	1 3/4	4 1/2	3 1/8	3 5/8	8
1 1/2	1 7/8	4 1/2	3 1/4	3 3/4	8
1 5/8	2	5	3 3/8	3 7/8	8
1 3/4	2 1/8	5	3 1/2	4	8
1 7/8	2 1/4	5	3 5/8	4 1/8	8 1/2
2	2 3/8	5 1/2	3 3/4	4 1/4	8 1/2
2 1/8	2 1/2	5 1/2	3 7/8	4 3/8	9
2 1/4	2 3/4	5 1/2			
2 3/8	2 7/8	6			

SQUARE □ BARS.

Bar.	Upset.		Bar.	Upset.	
Side. Inches.	Diam. Inches.	Length Inches.	Side. Inches	Diam. Inches.	Length Inches.
3/4	1 1/8	4	2 1/8	3	6
7/8	1 1/4	4	2 1/4	3 1/8	6 1/2
1	1 1/2	4	2 3/8	3 3/8	7
1 1/8	1 5/8	4 1/2	2 1/2	3 1/2	7
1 1/4	1 3/4	4 1/2	2 5/8	3 5/8	8
1 3/8	2	5	2 3/4	3 7/8	8
1 1/2	2 1/8	5	2 7/8	4	8
1 5/8	2 1/4	5	3	4 1/8	8 1/2
1 3/4	2 1/2	5 1/2	3 1/8	4 3/8	9
1 7/8	2 5/8	5 1/2	3 1/4	4 1/2	9
2	2 7/8	6			

Shape of thread, U. S. standard



Diameter of screw ends	1"	1 1/8"	1 1/4"	1 3/8" and above.
No. of threads per inch	8	7	7	6

*Minimum excess at root of thread over body of bar, 12.4 per cent.

*Amended to read: "Minimum excess at root of thread over body of bar, 15 per cent.

The Committee is not unanimous as to the advisability of recommending this table for adoption. Below are the opinions of the members who have responded since the dissent from Mr. Condron was issued.

The existing schedules of upsets used by manufacturers and engineers vary widely; and, while it is true that but a small proportion of the upset rods made in the country are used for "iron and steel structures," with which the Committee are supposed to deal, it is entirely within our province to recommend a table which may be looked upon as standard.

The apparent departure from many existing tables is due, in the case of the larger sizes, to the adoption of six threads per inch for all diameters over 1¼ in. This departure from the United States standard threads is prescribed in paragraph 53, Specifications for Steel Structures, 1903, and is approved and recommended by many manufacturers and users of screw rods and bolts.

A series of experiments made by Maj. Wm. R. King, U. S. A., show conclusively that threads much finer than those recommended had no tendency to strip and were preferable in every way to the ordinary standard. These experiments were described in a paper by Major King read at the Chattanooga meeting of the American Institute of Mining Engineers in 1885. It will be seen that several of the Committee favor these threads in preference to the U. S. standard and that all the experiments cited favor them. In fact, unless we repudiate our action at the last annual meeting in adopting clause 53 of Specifications for Material and Workmanship, we must reduce the upsets from the sizes formerly used with larger threads.

In December last a table of upsets and other data regarding screw ends was sent to the Committee, and after discussion by correspondence was quite thoroughly gone over at a meeting in New York, January 21, where eight of the ten members were in attendance. The table as given above was adopted by a practically unanimous vote. Dissent from this table has since developed and the result of subsequent correspondence is appended.

Action by the Association is desired: first, as to whether or not the Committee shall prescribe a scheme of upsets; and, second, as to the table presented or some modification of the same.

Mr. Condron writes under date of February 1:

"It seems to me there are matters of greater importance for our Committee to report upon than standard upsets, and, therefore, I am not in favor of our recommending any standard at this time until we have some experimental data to base recommendations upon."

Mr. August Zeising, Western Manager American Bridge Company, Chicago, Ill.:

Dear Sir:—I attach hereto certain correspondence between myself and Mr. J. P. Snow, Chairman of the Committee on Metal Structures of the American Railway Engineering and Maintenance of Way Association, regarding a table of standard upsets. It seems to me that this is merely a manufacturers' problem, but if I am mistaken in opposing the matter regarding the adoption of such a table, I should be very

glad to withdraw my opposition. Before doing so, however, I take the liberty of referring the correspondence to you, and will be greatly obliged if you will let me know how the matter strikes you, as representing a bridge company.

I will thank you for an early reply and return of the papers, as the report referred to in Mr. Snow's letter will be placed in the hands of the printer within the next two or three days, and I must, therefore, reply with as little delay as possible.

Awaiting your advice, I remain, Yours truly,

T. L. CONDRON.

Chicago, February 9.

Mr. T. L. Condron, Monadnock Block, Chicago, Ill.:

Dear Sir:—I have your letter of the 9th which refers to the changes in sizes of upset rods which the American Railway Engineering and Maintenance of Way Association expect to recommend.

From an engineer's standpoint, I would certainly prefer the size given in the Carnegie Handbook, and see no reason why the size of these upsets should be changed. It is true that the table now in use was made up when rods were mostly made of iron, but I would consider this all the more reason why the size should not be reduced now that we are using mostly steel. I would much rather trust an iron rod made out of what we considered some years ago as good "bridge iron" than the present steel rod when it comes to cutting a thread onto it. The cutting of a thread and the knicking of the steel rod do much more injury to it than the same would to an iron rod.

I do not find in this correspondence any reason whatever for making a change, and, as most all of the bridge companies have dies corresponding with the table given in Carnegie's book, it would certainly cause a great deal of confusion and expense to make so radical a change as you suggest.

I fail to see why and I cannot imagine any good reason for our Association meddling with a matter of this kind, and think the best thing you can do is to use your efforts in dropping this matter without making any report whatever. Yours truly,

AUG. ZEISING,

Chicago, February 10. Vice-President.

DISSENTING OPINION.

T. L. CONDRON.

In view of the fact that the proposed table of upsets differs in the diameters of upsets from those commonly in use at the present time, and in every case this difference would make the upset ends smaller than now customary, the writer objects to the adoption of the table as offered. The sizes of upsets given in the Carnegie Handbook for several years past are in use by a large number and probably the majority of the bridge companies making upset rods. These shops are all equipped with dies corresponding with the Carnegie table, and it would cause unnecessary confusion and expense to make additional dies to correspond with the table proposed by this Committee. It is wiser to increase the size of details for bridges, where any change is made, rather than decrease, and while the diameters of upsets given by Carnegie were for iron rods rather than steel, experience has not shown that we are justified in reducing these sizes of upsets on steel rods.

No changes should be made in matters of this sort without experimental data to base them upon.

For these reasons the writer objects to the adoption of the table.

Mr. M. F. BROWN, member of Committee, says:

"In regard to table on upsets, would say that I see no reason why the Committee should change the decision arrived at in New York. I should, therefore, be in favor of putting the matter before the annual meeting, if possible."

Mr. C. C. SCHNEIDER, member of Committee, says under date of February 15:

"As far as Mr. Condron's objections are concerned, I would say that the Carnegie standards for upsets are not in existence at this time. The Carnegie Handbook simply copied the old Keystone standards. The Keystone Bridge Company's plant is about to be dismantled, and is not in a position to make any more upset rods. These upset rods will now be made at the Ambridge plant, which has already adopted our standards."

And again March 1:

"In reference to the table of standard upsets and Mr. Condron's dissent, I must confess that I cannot find any good reasons therein for objecting to the table. I am sorry that this table was not included in the February Bulletin, which would have given the members of the Association an opportunity to criticise the same. I am, therefore, in favor of having the table printed in a leaflet and brought before the annual meeting.

"I have before me a table of standard upsets which were used formerly for Howe truss bridges. This table only allows a very small excess; in fact, the diameters of the upsets are practically the same as our revised table with finer threads. Of all the tests which have been made at the Pencoyd Works during the last fifteen years on upset bars, more particularly those used as counters in bridges with loop ends, I do not know of a single case where the break occurred in the threads of the upset; but they most always broke in the body of the bar—once in awhile in the loop."

Mr. J. R. WORCESTER, member of Committee, says:

"I have carefully considered Mr. Condron's discussion on the table of upsets, but am not disposed to accept his views in the least degree. It has always been my opinion that the allowances of the old Keystone table were excessive, and I fully believe in the advisability of increasing the number of threads per inch for larger diameters, which naturally involves the use of smaller upsets. I should be very glad if it were possible to have the table published this spring."

Mr. W. M. HUGHES, member of Committee, says:

"Relative to the matter of upsets, while I think the table is all right, I am not sure that we ought to adopt it at the present time. I am advised from the office of the American Bridge Company in Chicago that it has not yet been adopted by them, as Mr. Schneider states; however, they may have referred to the Chicago plants. If our specification requires the bridge companies to make an upset that will develop the full strength of the bar, it seems to me it is all we can ask. I am satisfied that if all the bridge companies could be induced to adopt this table, it would be a good thing for everybody interested. I am heartily in favor

of fine threads for large screws. During the two years I was with the Keystone Bridge Company, in 1889-1890, we made all large screw ends, I think, six threads to the inch, possibly it was eight threads, unless otherwise specified. We made quite a number of tests and got more favorable results from the fine threads than we did from the standard."

Mr. JOHN BRUNNER, member of Committee, says:

"In regard to the upset of rods, I feel satisfied that the proposed upset will fully develop the strength of the main body of the rods. It is, however, doubtful if it would be advisable for the Association to adopt a standard for this detail at the present time. It looks to me as if we had many more important questions to settle before we go into these details, and there is no doubt but that a great deal of objection will be raised against the incorporation of this new standard of upsets in our specifications.

"I do not believe that, at the present time, we should go farther than to specify that upsets shall be made to develop the full strength of the body of the bar. A clause similar to clause 47, covering eyebars, in our specifications, would be all that we should specify at the present time; or, in other words, that the size and form of the upset will be determined by the dies in use at the works where the upsets are made. if satisfactory to the engineer, but the manufacturer shall guarantee the bars to break in the body with a silky fracture when tested to rupture.

"I notice a conflict between threads as marked on standard upset table and clause 53 for screw threads in the adopted specifications. The standard upset table specifies that for diameters of screw ends 1⅜ in. and above, six threads per inch shall be used, while the adopted specifications read that screw threads shall be U. S. standard, except at the ends of pins and for bolts over 1½ in. in diameter, for which six threads per inch shall be used.

"If the American Bridge Company's plant at Ambridge has adopted the new standard for upsets, it will only be a question of time when these standards will be adopted by other bridge plants, but it would be a hardship on many small shops to specify that the new standard must be used, just as much as it would have been a hardship to the eyebar plants a few years ago to specify that a certain size and shape of heads for eyebars should be used."

Mr. J. P. SNOW, Chairman of Committee:

I think this table should be adopted by the Association. Within a year I have had to specify many tons of upset bars for wooden bridges, and other departments of our railroad have used many more tons of similar material. These bars are not always made by bridge shops, as seems to be supposed by some who are quoted above, but by many bolt manufacturers and other iron-working establishments. There has never been anything like uniformity in the schedules used by the various works, the great majority, according to my knowledge, using sizes which give practically no excess at root of thread over the body of the bar. Opinions may differ as to the relative importance of this and other work that the Committee might do, but this work is already done and its adoption by the Association will not interfere with other work.

There is no discrepancy between the table proposed and paragraph 53, as stated by Mr. Brunner; because the U. S. standard prescribes six threads per inch for 1⅜ and 1½ in. diameters.

This table need not necessarily be a part of our specification. It was made at the suggestion of President McDonald, to cover a request

from a manufacturer for the standard upsets of the Maintenance of Way Association. I think it should be adopted.

Respectfully submitted,

J. P. SNOW, *Chairman.*

DISCUSSION.

The President:—The convention will probably recall there has been a leaflet distributed with regard to standard upsets, the leaflet showing that the Committee was divided. It appears now that the Committee has been able to almost get together. The question of bringing it before the convention was voted down. If two-thirds of the members vote in favor of reconsidering that matter, it will be brought up.

Mr. Wm. R. Webster (Consulting and Inspecting Engineer) :—I think we should do all we possibly can to help the Committee in their work and harmonize the differences—it advances the work a year and can be done very quickly.

Mr. Walter G. Berg (Lehigh Valley) :—The table of standard upsets as presented in this leaflet for round and square bars reads "Minimum excess at root of thread over body of bar, 12.4 per cent." I move that the table of standard upsets be adopted, with the proviso that the minimum of excess at root of thread over body of bar shall be 15 per cent, and the figures in the table be corrected accordingly.

Mr. Webster:—I rise to second that motion, and to explain that 15 per cent at the base of the thread will insure the bars when tested breaking on the body. You are taking no chances whatever on 15 per cent excess.

(Mr. Berg's motion was carried.)

REVISION AND CHANGES OF ADOPTED SPECIFICATIONS FOR MATERIAL AND WORKMANSHIP FOR STEEL STRUCTURES.

DISCUSSION.

Mr. William R. Webster (Consulting and Inspecting Engineer):—I merely want to say, if it is in order, that in the discussion of the general rules on Tuesday, it was decided that when papers were read by title they were open for discussion.

The President:—The point of order is well taken.

Mr. Webster:—I wish to say that clauses 9 and 10, on pages 62 and 63, of Bulletin No. 41, relating to structural steel, are contradictory. What I want to get at is this: That we want as many tests as possible on the material in the condition that it leaves the rolls. We still have the old blanket clause here that when material is to be annealed or otherwise treated before use, the specimen representing such material be similarly treated before testing. The mills are ready to give the bending test on an eyebar material in the condition it leaves the rolls. The Committee has had this matter up, and I think it can be embodied in the specifications at this time, so that we can get the advantage of that.

The President:—We will consider first the point which Mr. Webster first made. This matter of Iron and Steel Structures was not in the form of a committee report. It was merely submitted by the Committee to enable us to have it published in our Proceedings and to be used as a basis for a report which was to follow. It is desired by the Committee to alter three of these paragraphs in such a way that they can be used in the specifications. Am I not correct?

Mr. Webster:—No, sir; the specifications were adopted a year ago. This is in reference to specifications which were adopted and which are in use to-day, but during the year the Committee has seen the trouble that these clauses are likely to give. The mills are willing to meet the changes which I desire to refer to.

The President:—The gentleman will state the changes.

Mr. Webster:—I think Mr. Schneider, a member of the Committee, is here, and if he will give the conclusions of the Committee, it will save time to have him do it. I merely want the Committee to show the good work they are doing.

Mr. C. C. Schneider (American Bridge Company):—On behalf of the Committee No. 15, on Iron and Steel Structures, I wish to state that in accordance with suggestions received since the last annual meeting your Committee has revised paragraphs 2, 9, 13, 16 and 33 of the adopted specifications for material and workmanship, which it desires to bring before this convention. The changes are contained in a draft for-

warded to me by the chairman of your Committee, which I herewith submit to the Secretary.

The President:—You want to introduce them to have them incorporated in the new specifications?

Mr. Schneider:—Yes, sir.

The President:—They will have to be read and approved by the convention.

The Secretary:—

"2. The chemical and physical properties shall conform to the following limits:

Elements Considered.	Structural Steel	Rivet Steel	Steel Castings.
Phosphorus, max... { Basic.....	0.04 per cent.	0.04 per cent.	0.05 per cent.
{ Acid.....	0.08 " "	0.04 " "	0.08 " "
Sulphur, maximum.....	0.05 " "	0.04 " "	0.05 " "
Ultimate tensile strength. Pounds per square inch.....	Desired 60000	Desired 50000	Not less than 65000
Elong., min. % in 8", Fig. 1.... {	1,500,000* Ult. tensile str'gth	1,500,000 Ult. tensile str'gth	
" " " 2" " 2.....	22		18
Character of Fracture.....	Silky	Silky	{ Silky or fine granular
Cold Bends without Fracture.....	180° flat†	180° flat‡	90°

* See paragraph 11. † See paragraphs 12, 13 and 14. ‡ See paragraph 15.

"The yield point, as indicated by the drop of beam, shall be recorded in the test reports.

"9. Material which is to be used without annealing or further treatment shall be tested in the condition in which it comes from the rolls. When material is to be annealed, or otherwise treated before use, the specimens for tensile tests representing such material shall be cut from properly annealed or similarly treated short length of the full section of the bar.

"13. Full-sized material for eye-bars and other steel 1 inch thick and over, tested as rolled, shall bend cold 180 degrees around a pin, the diameter of which is equal to twice the thickness of the bar, without fracture on the outside of bend.

"16. Finished material shall be free from injurious seams, flaws, cracks, defective edges or other defects, and have a smooth, uniform and workmanlike finish. Plates 36 inches in width and under shall have rolled edges.

"33. When general reaming is not required, the diameter of the punch for material not over ⅝ inch thick shall be not more than 1-16 inch, nor that of the die more than ⅛ inch larger than the diameter of the rivet. Material over ⅝ inch thick, except minor details, and all material where general reaming is required, shall be sub-punched and reamed as per paragraph 61, or drilled from the solid. Holes in flanges or rolled beams and channels used in floors of railroad bridges shall be drilled from the solid. Those in webs of same shall be so drilled or sub-punched and reamed."

The President:—Under strict construction of our rules, this report not having been published, the Committee would have no right to make it; but the chair considers it a matter of such importance that we should at least give the Committee an opportunity of having these specifications corrected for use during the year.

Mr. Webster:—I make the motion that the new clauses be substituted for the old clauses, and will make the explanation that the new

clause 9 enables the railroad companies to get a bending test on the material as rolled, which is a better check on its character and is a decided step in the right direction.

(The motion was carried.)

MR. C. M. MILLS (Philadelphia Elevated Railroad and Subway—by letter):—I submit herewith a short discussion on several points in the specifications for steel:

YIELD POINT.—In the light of all the discussion on this subject, I believe that it may be considered that the specifications of the Committee, with respect to this property of steel, are a compromise, the best under existing conditions, but which leaves at the same time a want which it may be found practicable to supply in the near future.

If the yield point or the elastic limit were a necessary corollary from the physical and chemical properties prescribed in the specifications, the elimination of the yield point or elastic limit as a requirement for the acceptance of the material would naturally follow.

There is no doubt that the present reports of the yield point, in most specifications still termed the elastic limit, are very erroneous and misleading.

I know of an instance where the variation of the elastic limit, so reported, and the yield point as determined on an autographic register, varied 10,000 lbs. per square inch. There is no uniformity of differences between the reported elastic limit and the real yield point as carefully determined to justify making allowances to get the probable true yield point. The question arises whether in the future it would be found advisable for engineers to insist upon sufficient provision for testing at prescribed speeds, with the necessary attendance to make observations. If this were accomplished, the testing appliances in many mills would have to be increased to keep up with the output. The purchasers, of course, would have to pay any increase in the cost of more deliberate and accurate testing.

The writer has included in a specification recently a proviso that duplicate test pieces for check determinations of the yield point shall be supplied free of charge when required, the duplicate test pieces to be cut from the identical bars and from the same part of the bar, as nearly as practicable, from which the regular test pieces are cut. This is done with a view to have autographic tests made when desired.

BENDING TEST FOR STEEL CASTINGS.—The specification, while it prescribes a bending test for steel castings, requiring to bend 90 degrees, does not say how large a bar should be used around which the specimen should be bent. I would suggest that for the size of specimen prescribed, the piece about which the bend should be made be one inch in diameter.

ANNEALED SPECIMENS.—The writer for several years has had the following covering this point:

"Material which is to be used without annealing or further treatment is to be treated in the condition in which it comes from the rolls. When material is to be annealed or otherwise treated before use, the specimen representing such material shall be cut from full sections of material similarly annealed or treated."

I notice in a recent Bulletin that this has been taken up by the Committee, and would recommend that an amendment be made to the paragraph as it now stands in the printed specifications.

RODS FOR REINFORCED CONCRETE.—In view of the increasing use of formed rods for reinforced concrete, would it not be well to incorporate a paragraph in the specifications covering this material? The following is a draft of a specification recently prepared by the writer:

"In testing material in rods for reinforced concrete, both formed and plain, the specimens shall consist of sample pieces of full-sized rods, and in formed rods the samples shall be so taken as to most thoroughly indicate the quality of the finished rods, either from the ends or from the middle of the rods, as the Inspector may find advisable.

"Formed rods for reinforced concrete shall be tested at the mills before forming, and each melt of steel used shall be represented by at least one test. After being formed, each size of rod shall be represented by at least one test for each day's work."

The foregoing prescribed tests refer to material made from the same grade of steel as used for bridges. It is very doubtful if there is any gain in using higher steel than that so readily procurable, and with such uniformity in quality as that now so generally used for bridge work.

VARIATION IN WEIGHT.—I think it would be well, as a means of avoiding dispute in settlement of pound price contracts, to have the specification provide for an allowable variation in weight, for which payment would be made. I have looked over a number of specifications and fail to find provision for this detail, except in one. Perhaps there may be others. I have heard of a number of instances where there has been trouble occasioned by a lack of previous agreement covering this particular.

I would suggest for discussion that a paragraph like the following be considered:

"A diminution in cross-section or weight of any piece of steel of more than 2½ per cent. from that specified will be sufficient cause for rejection.

"Plates will be accepted if they measure not more than .01 inch below the ordered thickness at the finished edges.

"Payment for pound price contracts shall be by scale weights, and no allowance will be made in payment for excess weight exceeding 2½ per cent. of the weight computed from the plans, 1 cubic inch of rolled steel being assumed to weigh 0.2833 lbs."

It may be said that the necessity for the insertion of a restriction as to overweight in pound price work has not been found necessary, but in view of information I have received, I believe it is wise to have a previous understanding in specifications to cover this detail. It is a question whether the 2½ per cent. specified above is a proper allowance, but I believe in the miscellaneous distribution of various structural shapes and plates that it would represent a fair variation. I have been informed that on a long plate girder structure for a railroad bridge, the actual excess in the shipping weight over the computed weight from the plans did not exceed 2 per cent.

REPORT OF COMMITTEE NO. XIII.—ON WATER SERVICE.

To the Members of the American Railway Engineering and Maintenance of Way Association:

Your Committee on Water Service has held several meetings and has collected information on the subject of "Water Supply for Railroad Use." It finds that the question of obtaining soft water for use in boilers is one that a great many railroad officers have recently become very much interested in, and many railroad companies have commenced to invest large sums of money in storage reservoirs, pipe lines, water-softening plants, filters, and such well-known means for improving the character of the water used in boilers. The entire subject of Water Supply for railroads may be said to be undergoing a radical change, and quality is now being considered where a few years ago quantity only was thought of. This time, therefore, might be called the transition period in railroad Water Supply, and your Committee does not think it a proper time to make a full and final report, feeling that it would be much more in accordance with the policy of this Association to offer now a progress report and wait until the subject has been more thoroughly studied before submitting a final report.

While your Committee does not wish to ignore the character of the water used by railroads for drinking purposes, yet that branch of the subject has been carefully investigated by municipalities, water companies and sanitary engineers, and so much valuable information has been published, that your Committee feels it could accomplish more for the Association if it devoted its time to water for boiler use only. The following is, therefore, respectfully submitted:

SUMMARY OF CONTENTS OF PREVIOUS REPORTS.

1900: The preliminary report contained a brief discussion of the three general divisions of the subject of Water Service, namely (1) Source of Supply; (2) Method of Pumping and Supply; (3) Character of Water. No conclusions or recommendations were made. (Pp. 54-58, Vol. 1, 1900.)

1901: The report for 1901 consisted of sub-committee reports on the three sub-divisions of the Committee's work: Source of Supply; Method of Pumping and Supply, and Character of Water. No conclusions or recommendations were embodied in the report. (Pp. 219-230, Vol. 2, 1901.)

1902: No report submitted.

1903: The report for 1903 was not discussed by the convention, and hence did not appear in the Proceedings.

KINDS OF WATER USED IN RAILROAD BOILERS.

The water used in railroad boilers is practically limited to that found in the territory in which the railroads are located. While it is, of course, possible to haul water, yet the expense of this is almost prohibitive, except in extreme cases.

The quality of the water used by railroads varies between wide limits. It depends largely upon the character of the geological formations with which this water comes in contact.

In general terms there are four distinct classes of water used by American railroads for steam making, namely:

(1) Natural Soft Water.
(2) Hard Water.
(3) Alkali Water.
(4) Corrosive Water.

The first of these classes, viz., Natural Soft Water, is generally obtained from streams, lakes, ponds and similar reservoirs that are supplied by melted snow or rain. In portions of New England, Northern New York, Michigan, Wisconsin, Minnesota, and other parts of the United States, where the geological formations are largely rocks that are nearly insoluble in water, and much of the water is derived from melted snow that is stored up in swamps and lakes and by them supplied to streams, the water is generally good for boiler use, because it does not contain much mineral matter in solution.

The second of these classes, viz., Hard Water, is generally obtained from wells and springs that produce water that has percolated through the soil and often has traveled some distance under the surface of the earth. It is sometimes obtained from streams that are largely fed by springs and do not contain much water that has not been through the ground. In Ohio, Indiana, Illinois and many portions of the Central and Southern States, where limestone is found, the water is generally hard and deposits scale in the boilers. Such water can be softened and made good for boiler use by treatment with chemicals.

The third of these classes, viz., Alkali Water, is generally obtained from deep wells or springs. Small streams and lakes in some localities often contain such water, especially during a season of drought, when their source of water is almost entirely that obtained from wells or springs that produce alkali water. In many parts of the Southwest, West and Northwest the water used by railroads contains salts of sodium and potassium and is known as alkali water. While these salts do not form scale in boilers, yet they are said to cause boilers to foam. No practical method has yet been discovered for removing alkalies from water except distillation, and the cost of this has been prohibitive.

The fourth of these classes, viz., Corrosive Water, is often found in streams into which is discharged the water from coal and other mines, or the refuse from industrial plants. This corrosive action is due to the presence of mineral acid, generally sulphuric. The water from rapid running streams that have waterfalls in them is corrosive on account of the large amount of oxygen and carbonic acid gas absorbed from the air.

Water from peat bogs is corrosive on account of organic acids dissolved in it.

Water that contains certain salts, like magnesium chloride, is corrosive on account of the acid set free by the decomposition of these salts. The corrosive action of water of this class can be removed by treatment with chemicals, and after such treatment the water is good for boilers.

In locating water-supply stations it is, as a rule, advisable to avoid taking water from wells, if water can be obtained from lakes or streams. Well water usually has a bright, clear appearance, and for that reason is often selected in preference to river water that may contain suspended matter at certain seasons; yet the well water may contain in solution so much solid matter, which will be deposited in the boilers, that its use will prove to be very expensive. Your Committee's attention has been called to the location of one railroad that for several hundred miles ran close to the bank of a large river, the water of which is unusually soft and good for boilers, yet the water supply for this railroad was taken largely from wells that produced hard water. When this line was absorbed into a larger system, one of the first changes made was to abandon the wells and use water from the river.

CHARACTER OF THE IMPURITIES FOUND IN BOILER WATER.

The impurities usually found in boiler water may be classified as follows:

(1)—SCALE-FORMING IMPURITIES.

Matter in suspension consisting of sand, clay, dirt, etc.

Matter in solution consisting of carbonate of lime, carbonate of magnesia, sulphate of lime, sulphate of magnesia, carbonate of iron, carbonate of alumina, silica.

(2)—NON-SCALE-FORMING IMPURITIES.

Matter in suspension consisting of leaves, grass, small bits of wood, and other organic matter.

Matter in solution consisting of sulphates of the alkalies (sodium and potassium), chlorides of the alkalies (sodium and potassium), carbonates of the alkalies (sodium and potassium).

(3)—CORROSIVE IMPURITIES.

Matter in suspension consisting of vegetable matter that is decomposed in the boiler.

Matter in solution consisting of magnesium sulphate, magnesium chloride, calcium chloride, acids, both inorganic and organic, organic matter, iron sulphate.

Of these the first and third classes cause most of the trouble with water in boilers. The impurities of these two classes can be removed from the water before it is put into boilers by proper treatment with chemicals. In most localities the principal trouble is due to the carbonates and sulphates of lime and magnesia that are in solution, causing the water to be hard.

The hardness of water is often described as temporary hardness and permanent hardness. By temporary hardness is meant that due to the carbonates of lime and magnesia. This hardness can be removed simply by boiling the water. By permanent hardness is meant that due to the sulphates of lime and magnesia. This hardness cannot be removed by boiling.

If these compounds of lime and magnesia are removed from water it will be soft. They can be precipitated by treating the water with chemicals. Any matter in suspension in the water will at the same time be precipitated.

THE TREATMENT OF BOILER WATER.

HISTORICAL.

The principles of water softening have been known for many years. The first commercial process for softening water was patented by Clarke, of Scotland, in 1841. By his process Clarke removed the lime and magnesia carbonates from hard water by adding to the hard water the proper amount of slaked lime required to combine with the carbonic acid that held them in solution. Some years later Porter suggested the use of carbonate of soda for decomposing the lime and magnesia sulphates. The Clarke-Porter process is the basis of practically all of the commercially successful water-softening plants that are in use at the present time. The chemical principles involved are simple.

ANALYTICAL.

To precipitate lime and magnesia carbonates from hard water it is only necessary to remove from the water the carbonic acid gas that holds them in solution. Common slaked lime is the cheapest known chemical that will do this and not leave any by-product in the water.

To precipitate lime and magnesia sulphates from hard water it is necessary to decompose them. Carbonate of soda, commercially known as soda ash, is the cheapest known chemical that will do this. It leaves dissolved in the water as a by-product sulphate of soda. This does not form scale.

The process of water-softening may be divided into two parts, namely:

(1) Mixing with the hard water the proper quantity of slaked lime required to precipitate the carbonates of lime and magnesia and also the proper quantity of soda ash required to decompose the sulphates of lime and magnesia. The hardening matter is thus taken out of solution but left in suspension.

(2) Separating the matter in suspension from the softened water. The process, therefore, is a mechanical as well as a chemical one.

TYPES OF WATER-SOFTENING PLANTS.

There are two general types of water-softening plants, namely, the intermittent type and the continuous type.

In the *intermittent type* the hard water is mixed with the proper quantity of chemicals and the mixture allowed to stand in one or more large tanks or reservoirs until the solid hardening matter that is thrown

out of solution by the chemicals has settled. The clear softened water above the precipitated solid matter is then drawn off, generally through a suction pipe attached to a float, and used at once or stored in a supply tank. When after some weeks it becomes necessary to remove the precipitated solid matter from the tanks or reservoirs, it is diluted with hard water and allowed to run out through a hole in the bottom.

In the *continuous type* the top of the apparatus is located above the top of the supply tank. The hard water and chemicals are mixed at the top of the apparatus and then passed through one or more chambers that are provided with plates or other devices designed to collect the precipitated solid matter and deliver it at the bottom of the apparatus, from whence it is discharged daily. The soft water generally passes finally through a filter and is discharged into a supply tank.

COST OF WATER-SOFTENING PLANTS.

The cost of a water-softening plant set up ready for use varies from, say, $2,000 to $10,000, or more, depending largely upon the type of plant, its capacity and local conditions.

COST OF SOFTENING WATER.

The principal item of expense of softening water is for chemicals. The item of labor is small, because the little extra labor required—such as weighing out the chemicals—is usually done by the regular pumper. The amount of chemicals required varies according to the quantity of lime and magnesia compounds that are to be removed from the hard water. The character of these compounds also affects the cost. If the hardness is due to carbonates, such hardness is removed by the use of slaked lime alone, and the cost, therefore, is much lower than if the hardness is partly or wholly due to sulphates, which are removed by the use of soda ash. The average cost for chemicals required to soften the railroad water supply in the territory between Chicago and the Missouri River is 1.4 cents per 1,000 gallons.

PRACTICAL RESULTS OBTAINED IN EUROPE.

The softening of water has been common practice by European railroads for a long time. The success of this practice is so assured that thousands of water-softening plants are to-day used by European railroads. The subject was thoroughly discussed at the meeting of the International Railway Congress in January, 1902. The following was adopted at the final conclusion of the discussion:

Resolved, that it is a very good thing to purify beforehand the feed water for locomotives, whenever it is not sufficiently pure, in order to improve the working of the boilers and reduce the cost of washing out and repairing them, as well as the laying up caused thereby.

AMERICAN RAILROADS THAT HAVE INSTALLED WATER-SOFTENING PLANTS.

It is only very recently that American railroads have commenced to soften water for boiler use, yet twenty-seven of them are known to your

Committee to have installed water-softening plants. They are as follows:

Atchison, Topeka & Santa Fe Railway,
Buffalo, Rochester & Pittsburgh Railway,
Chicago & Alton Railway,
Chicago & Eastern Illinois Railroad,
Chicago & North-Western Railway,
Chicago, Burlington & Quincy Railway,
Chicago, Milwaukee & St. Paul Railway,
Chicago, Rock Island & Pacific Railway,
Chicago, St. Paul, Minneapolis & Omaha Railway,
Cincinnati, Hamilton & Dayton Railway,
Cincinnati Northern Railroad,
Delaware, Lackawanna & Western Railroad,
Denver & Rio Grande Railroad,
El Paso-North-Eastern System,
Hocking Valley Railroad,
Ivorydale & Millcreek Valley Railway,
Lehigh Valley Railroad,
Missouri Pacific Railway,
New York, Ontario & Western Railway,
Pennsylvania Lines West of Pittsburgh,
Pittsburgh & Lake Erie Railroad,
Rio Grande & Eagle Pass Railway,
Rio Grande Western Railway,
Southern Pacific Company,
Tennessee Coal & Iron Railway Company,
Union Pacific Railroad,
Wabash Railroad.

CHEMICAL RESULTS OF WATER-SOFTENING.

The following figures, which have been published, are quoted to illustrate the degree to which water softening can now be carried:

RESULTS OF ANALYSES, BEFORE AND AFTER SOFTENING, OF WATER USED IN LOCOMOTIVE BOILERS.

	U. P. R. R, North Platte, Nebraska.		C. & N W. Ry. Council Bluffs, Iowa.	
	Before.	After.	Before.	After.
Total Solid Matter, grs. per gallon	28.49	25.22	53.67	31.35
This Solid Matter consists of				
Carbonate of Lime, grs. per gallon.....	7.94	1.98	24.39	2.26
" Magnesia, " "	1.35	1.08	1.18	0.88
Sulphate of Lime, " "	4.53	.....	6.22	.....
" Magnesia, " "	2.43	.....	13.33	.....
Oxides of Iron and Aluminum, grs. per gal.	0.26	0.26	0.34	0.02
Silica, grs. per gallon.....	2.86	2.01	1.42	0.38
INCRUSTING SOLIDS, grs. per gallon..	19.37	5.33	46.88	3.54
Alkali Chlorides, grs. per gallon.....	3.30	3.24	1.21	1.27
" Sulphates, " "	5.82	16.32	5.58	26.54
" Carbonates, " "	.....	0.33	.....	.....
NON-INCRUSTING SOLIDS, grs. per gal.	9.12	19.89	6.79	27.81
Pounds of Scale-Forming Matter in 1,000 gallons.....	2.76	0.76	6.69	0.51

BENEFITS FROM USE OF SOFT WATER.

Some of the benefits derived from the use of soft water in boilers are as follows:

(1) Hard scale and corrosion avoided.
(2) Less fuel consumed.
(3) Decreased boiler repairs.
(4) More time in service.
(5) More satisfactory service.
(6) Fewer boilers in service.
(7) Longer life of boilers.

(1) *Hard Scale and Corrosion Avoided.*—It is a well-known fact that the scale found in boilers is a poor conductor of heat. The amount of heat retarded depends somewhat upon the nature of the scale. Moreover, much scale deposited in a boiler seriously interferes with the proper circulation of the water in the boiler.

(2) *Saving in Fuel.*—Authorities differ as to the extra amount of fuel required to convert water into steam in boilers coated with scale. One authority has stated that one-sixteenth of an inch of scale is equivalent to a loss of 20 per cent. of fuel, and that the loss increases in a rapid ratio with the increase of thickness of the scale. Another writer states that one-quarter of an inch of scale necessitates the use of 50 per cent. more fuel. There seems to be no question but that the efficiency per unit of coal is increased if a boiler is free from scale, but your Committee has no definite information as to the exact amount.

(3) *Decreased Boiler Repairs.*—Practical experience has shown that the use of soft water has greatly reduced the amount of boiler repairs. It is an established fact that boilers using soft water give very little trouble from leaky flues. A Superintendent of Motive Power has stated that since the installation of seventeen water-softening plants on a busy division of his road, twelve boilermakers are now required to keep up the boiler repairs where twenty-three were needed before the plants were installed. The Chief Engineer of another railroad that has ten water-softening plants in operation on one division has stated that these plants are removing 2,790 pounds of incrusting solids from the water per day, and that the saving in boiler repairs alone warrants the expenditure of the amount necessary to treat the waters. Another railroad has recently completed new repair shops that are strictly modern in every respect. In designing the boiler shop the floor space was made considerably less than the average for repair shops of similar capacity. This road has installed ten water-softening plants, and has found from practical experience with them that the repairs to boilers were so much decreased that it would not be necessary, in order to keep up their boilers, to build a boiler shop of the usual capacity.

(4) *More Time in Service.*—Inasmuch as the use of soft water decreases the amount of boiler repairs, it is not necessary to take the boilers out of service so often for repairs. It has been found that the use of soft water has lessened very much the time a boiler is out of service, but your Committee has not been able to get exact figures.

(5) *More Satisfactory Service.*—It is well known that it is often difficult to maintain the desired pressure in a boiler that has scale in it, and that locomotives are often unable to pull their maximum tonnage rating because the boilers contain much scale deposited from hard water. Your Committee has endeavored to secure from the operating officers of railroads that have installed water-softening plants some information as to the comparative service of locomotives before and after the installation of the plants. One prominent operating officer states that the use of softened water has been of great help to him in the prompt and rapid movement of trains. Another has stated it would be a great advantage to have all the water used on his road softened so that locomotives could be transferred from one district to another and still use practically the same kind of water, because it is a well-known fact that when locomotives are transferred and the character of the water changed they generally give trouble for some time.

(6) *Fewer Locomotives in Service.*—Since the use of soft water decreases the time necessary for keeping locomotives out of service for boiler repairs, and for washing out, the number of locomotives required to operate a line should be decreased. Your Committee has found published statistics covering a period of time on a division of a railroad that recently was equipped with water-softening plants. These statistics show that the number of locomotives in service was 9 per cent. less, the ton mileage 11 per cent. more, and the pounds of coal consumed per 1,000 ton miles was 5 per cent. less than during the same period before the division was equipped with the water-softening plants.

(7) *Longer Life of Boilers.*—It is a well-established fact that a thick deposit of scale on boiler plates allows them to become overheated and often causes the plates to bulge and crack. It is also well known that boilers of locomotives that run in districts where the water is soft last much longer than the boilers of locomotives that run in districts where the water is hard. A test was recently made by a railroad with a locomotive that ran on a branch line and used nothing but water that had been softened. The boiler of this locomotive was kept hot continually for thirty days. It was noticed that the trouble due to leaky flues and staybolts was very much decreased.

It is considered good practice in the maintenance of boilers to keep them hot as much as possible. The wear and tear due to cooling off and reheating is considerable. The use of soft water does away with the necessity of doing this so often.

PROBLEMS.

Your Committee recognizes that there are many problems connected with water softening and the use of softened water in boilers that have not been satisfactorily solved. Among them are:

(1) How much does scale in boilers retard the passage of heat?

(2) What causes boilers to foam—matter in suspension, or solution, or both?

(3) What time is necessary for the soda ash and cold hard water to

be mixed together in order to insure the precipitation of all the sulphate of lime?

(4) Is it necessary or desirable to use coagulants, like sulphate of alumina, to hasten the settling of the matter in suspension or the solid matter precipitated from the water?

(5) Hard water can be softened to about 3 degrees of hardness. To what degree is it necessary to soften it to have it give good results in boilers?

(6) What is the average amount saved per year by the use of soft water in a boiler that was using hard water of a known analysis?

(7) What is the average mileage of a locomotive per 1,000 gallons using hard and soft water, respectively?

(8) What proportion of the scale-forming matter can be removed from hard water by passing it through a good feed-water heater and purifier?

RECOMMENDATION.

Your Committee thinks that this subject of Water Supply for Railroads is of sufficient importance to warrant an exhaustive investigation by your Association. It also feels that the present Committee has done all that it can in compiling information on this subject. We, therefore, recommend that a new Committee be appointed and that this new Committee consist of an equal number of Civil Engineers, Mechanical Engineers and Chemists.

Respectfully submitted,

J. L. FRAZIER, *Chairman;* General Superintendent, Toledo, St. Louis & Western Railroad, Frankfort, Ind.

O. D. RICHARDS, *Vice-Chairman;* Chief Engineer, Ann Arbor Railroad, Toledo, O.

J. A. BARNARD, General Manager, Peoria & Eastern Railroad, Indianapolis, Ind.

G. M. DAVIDSON, Chemist and Engineer of Tests, Chicago & North-Western Railway, Chicago, Ill.

F. A. DELANO, General Manager, Chicago, Burlington & Quincy Railroad, Chicago, Ill.

PAUL JONES, Engineer Maintenance of Way, Pennsylvania Lines, Columbus, O.

W. A. MCGONAGLE, Assistant to President, Duluth, Missabe & Northern Railroad, Duluth, Minn.

S. D. PUGH, Assistant Engineer, Pennsylvania Lines, Valparaiso, Ind.

C A. WILSON, Chief Engineer, Cincinnati, Hamilton & Dayton Railroad, Cincinnati, O.

Committee.

APPENDIX.

The following circular, containing the substance of the Committee's report for 1903, is republished herewith in order that it may be on record:

CIRCULAR NO. 42.

The Committee on Water Service invites discussion and criticism of its report presented at the last annual convention of the Association, given below. In its report the Committee has confined itself to the sub-heading of "Water Supply for Steam-Making," and treated the subject under the following heads:

(1) SOURCES OF SUPPLY—DEFINITIONS.
(2) CHARACTER OF WATER.
(3) METHODS OF PURIFICATION.

(1) SOURCES OF SUPPLY.

GENERAL DEFINITIONS.

(a) Surface Water Supplies:
  (1) Rain or snow water.
  (2) Flowing water. Streams.
  (3) Still water. Ponds, reservoirs and lakes.

(b) Ground Water Supplies:
  (1) Springs.
  (2) Shallow wells. Penetrating the surface strata only.
  (3) Deep wells. Penetrating impervious strata, or more than one geological stratum.

(2) CHARACTER OF WATER.

Waters for steam-making are classified as follows:

(A) HARD WATERS: Those containing one or more soluble salts of lime, magnesia, iron or alumina. These form precipitates and incrustations within the boiler. Such waters may also be corrosive if they should contain certain combinations of salts.

(B) SALINE AND ALKALINE WATERS: These contain soluble sulphates, carbonates or chlorides and are generally corrosive.

It is difficult to define by analysis sharply the line between good and bad water for steam-making purposes. For instance, water from two different sources of supply, each containing considerable quantities of im-

purities, may each be used separately without serious results, but when used together often give more or less trouble. The following, however, is submitted as being approximately correct:

Water containing incrustating and corrosive constituents may be regarded as follows:

Containing 5 grains or less per U. S. gallon.....GOOD.
From 5 to 12 grains per U. S. gallon.....FAIR.
From 12 to 25 grains per U. S. gallon.....POOR.
From 25 to 40 grains per U. S. gallon.....BAD.
Over 40 grains per U. S. gallon.....VERY BAD.

(C) SOFT WATERS.—Those containing a little soluble mineral matter and varying amounts of organic matter. These are good for steam-making and free from injurious results, except when they contain too much of certain classes of organic matter; peaty water, for instance.

All waters under headings A and B which analyze less than five grains per U. S. gallon can be classed under heading C.

(3) METHODS OF PURIFICATION.

Water containing incrustating constituents can usually be treated and purified by introducing into it in proper proportions precipitating reagents, the simplest and cheapest of these being lime and soda ash.

Water containing corrosive constituents of an acid character can usually be treated and purified by introducing into it in proper proportions neutralizing agents. Soda ash, caustic soda or lime may be used as neutralizing agents; the particular reagents to be employed depending in each case on the character of the corrosive constituents.

Water containing corrosive constituents of a saline character (such as magnesium chloride) may be successfully treated by introducing into it in proper proportions neutralizing reagents, of which the simplest and most common are soda ash and lime combined.

Waters under heading C, and containing large quantities of mud, sand and harmless organic matter, can be improved and clarified by filtration.

The application of treatment should stand in the following order:

(1) Treatment of the water before it is introduced into the station tank or similar reservoir.
(2) Treatment of the water in the station tank or similar reservoir.
(3) Treatment of the water in the locomotive tender.

DISCUSSION.

Mr. G. M. Davidson (Chicago & Northwestern):—We submit a progress report, and make certain recommendations which we would like to have the convention act on. We think the subject has become of considerable importance lately, and American railroads have begun to see the economy that can be derived from the use of soft water instead of hard water, but there is considerable lack of knowledge on this subject in the books, and the authorities do not always agree. Therefore we think it would be a good thing for this Association to make an exhaustive study of this subject and settle some facts, a few of which are mentioned, and many others will undoubtedly come up, so that the chances for disputing certain facts will be almost eliminated. We think that all civil engineers, mechanical engineers and chemists are jointly interested in this subject; the civil engineers owing to the fact that they are the class of engineers who locate and build the water stations and often operate them; the mechanical engineers are interested because they use the water in locomotive boilers, and they are the people who get the greatest good from the treatment of water. The chemists come in because the treatment is more or less of a chemical nature.

The President:—The request of the Committee is that its recommendations be taken up and considered by the convention. We will proceed under the provisions of the rules to consider the conclusions and recommendations of the Committee. The Secretary will read the recommendations of the Committee on page 17 of Bulletin No. 47.

The Secretary:—"Your Committee think that this subject of water supply for railroads is of sufficient importance to warrant an exhaustive investigation by your Association. It also feels that the present Committee has done all that it can in compiling information on this subject. We, therefore, recommend that a new Committee be appointed, and that this new Committee consist of an equal number of civil engineers, mechanical engineers and chemists."

Mr. John Dean (Civil Engineer):—I move that the recommendation of the Committee be adopted.

Mr. W. C. Cushing (Pennsylvania Lines):—I do not fully understand what the recommendation means. Does it mean a committee of our own members from these different walks in life, or are we to go outside and get some other people? I presume it means a committee from our own body.

Mr. Davidson:—Yes.

The President:—We have provided in our new Constitution that we can seek the opinion of outsiders, but cannot ask them to participate in committee-work.

Mr. Cushing:—We have so few mechanical engineers in the Association that I do not know what was intended.

Mr. Walter G. Berg (Lehigh Valley):—I understand by the term "mechanical engineers" it means railroad officials connected with the motive power department.

Mr. Davidson:—Yes, so understood.

The President:—In that case it would seem that the recommendation would mean that our Committee would confer with the mechanical department of railroads, in case we have no mechanical engineers in our own membership.

Mr. Cushing:—It does not seem to me altogether right to make that kind of recommendations. The matter of committee make-up belongs to the Board of Direction, and the Board of Direction is always willing to receive recommendations as to the make-up of committees, as they have stated distinctly several times in circulars, and we really do not arrive at anything by adopting this recommendation. It seems to me we do all we can if we adopt the report.

The President:—I understand Mr. Cushing would move that we proceed under item (c) of Rule 6.

Mr. Cushing:—There is a motion before the house to adopt this recommendation, and I am simply speaking upon it. I meant to convey the idea that I did not think that I would vote for receiving it in that way.

The President:—I think the point is well taken, and the effect of this recommendation would be, if adopted, that the convention is undertaking to instruct the Board of Direction as to the outline of committee-work, and that this recommendation lays down conditions which we may not be able to meet in the Board.

Mr. J. A. Atwood (Pittsburg & Lake Erie):—It seems to me that it is an unnecessary recommendation, even if it were practicable, because I think a committee of civil engineers is thoroughly able to investigate the matter and report intelligently to the Association, if they so desire. It might possibly be a good idea to appoint a Committee for the purpose of investigating the best methods of treating water, but that it should be composed of mechanical engineers, chemists, etc., I think is unnecessary, as a committee of engineers would be thoroughly competent to investigate the subject. I would, therefore, be opposed to the motion.

(The motion was lost.)

Mr. Cushing:—I move that the report be received as a report of progress.

(The motion was carried.)

Mr. H. Stillman (Southern Pacific—by letter):—Relative to Circular No. 42, I would present the following in discussion, but allowance must be made for local conditions and circumstances on the Pacific Coast, which, though not affecting principles involved, relate more or less to comparative values.

Character of Water.—The classification stated for steam-making water does not appear proper, as there may be confusion based on the following:

1st.—(A) "Hard waters containing one or more soluble salts of lime, magnesia, iron or alumina." These may be chlorides, sulphates or carbonates of the above bases, which are stated as contained in saline or alkaline water (B). The hardness of (A) waters is partly due to soluble carbonates, hence again, lack of definition between A and B.

2d.—(B) "Saline and Alkaline waters." I object to use of the term alkaline, as nearly all hard waters are alkaline as the term implies in chemistry. The test for temporary hardness is chemically expressed in terms of *alkalinity,* hence further possible confusion. The term saline I infer to apply to chloride sodium or common salt.

3d.—(B) "These contain soluble sulphates. carbonates or chlorides, and are generally corrosive." Without further definition all these are embodied in (A) and all go to make total hardness.

The difficulty appears to arise from the use of the word *alkaline,* which is intended to refer to *alkali,* the latter term being the general expression for the always soluble carbonates, sulphates and chlorides of sodium and potassium; the *alkali* metals.

4th.—As the total of all salts of lime and magnesia, as well as alumina, iron and silica, go to make incrustating matter by chemical reactions under influence of heat or pressure of the steam boiler, and it is evidently the purpose to distinguish between hard water and corrosive water, apart from *alkali* water, I would suggest the following, dividing the classification into four instead of three divisions, as follows:

(2) Character of Water.—(A) Hard waters: These contain one or more of the salts of lime, magnesia, iron or alumina, as well as silica. These form precipitates and incrustation within the boiler. Such waters may also be corrosive if they should contain the salts in certain combination.

(B) Corrosive Waters.—These containing either of the following:
(1) Chlorides lime and magnesia to exceed 5 grains per gallon.
(2) Sulphate magnesia to exceed 10 grains per gallon.
(3) Certain classes of organic matter (peaty matter) in excess.
(4) Waters having naturally an acid reaction.

(C) Saline and Alkali Waters.—These contain, *in excess of total incrustating matter,* the soluble chlorides, sulphates or carbonates of sodium and potassium. These salts are ordinarily neutral in boiler water, but are apt to cause priming or foaming in locomotive boilers. They do not deposit scale, but tend to concentrate.

Carbonate soda is especially apt to cause foaming if in excess or in presence of organic matter.

The sum of alkali and organic matter in water constitute the non-incrustating solids in distinction from the sum of lime, magnesia, iron, alumina and silicious salts which constitute incrustating matter.

It is difficult to define sharply by analysis the line between good and bad water for steam-making purposes. Water from two different sources of supply, each containing considerable quantities of impurities, may each be used separately without serious results, but when used together often give more or less trouble. This is especially the case where, as in the

locomotive, a hard water (A) or (B) is in use and the boiler takes a (C) or alkali supply. The following classification is submitted:

NOTE.—As relates to classification the figures stated in the circular are rather severe on us in the West. We would not often have a good supply. The following classification we use:

Containing 5 grains or less per U. S. gallon (incrustating and corrosive)	EXCELLENT.
5 to 12 grains	GOOD.
12 to 20 "	FAIR.
20 to 30 "	POOR.
30 to 40 "	BAD.
Over 40 "	VERY BAD.

(D) SOFT WATERS.—These contain a little soluble mineral matter, varying amounts of organic matter (except peaty) or carbonate soda (alkali). These are good for steam making and free from injurious results unless the organic matter or carbonate soda exist together, or separately, in excess, when foaming may result.

All waters under headings (A), (B), (C), which show 5 or less grains per U. S. gallon can be classed under heading (D).

(3) METHODS OF PURIFICATION.—Have no comment to make under this head except the fourth paragraph, which I would correct as follows:

"Waters under headings (C) and (D), and containing considerable quantities of mud, sand and organic matter, can be improved and clarified by filtration or by settling in ample basins or tankage."

The system by gravitation or settling is generally cheaper than cost of installation, maintenance and operation of filters.

NOTE.—In the three methods of application referred to in the circular, I would state for information that we have abandoned all methods except (1). Additional settling tanks are in operation overflowing into station or service tank. We have found it impracticable to treat water in the station or service tank.

MR. CHAS. B. DUDLEY (Pennsylvania R. R.—by letter):—Referring to Circular No. 42, a single point in the report of the Committee seems to me to be worthy of attention, namely, under (B), defining "Character of Water," saline and alkaline waters are those containing soluble sulphates, carbonates or chlorides, and are generally corrosive. For a long time now we have been accustomed to examine waters very carefully for their corrosive constituents, and while we do not think we have reached a final conclusion, we are inclined to the idea that if, when a water is evaporated to dryness, the salts left behind contain any carbonates, there is no danger of that water being corrosive, irrespective of what the water contains otherwise. In other words, suppose a water contains some chloride of magnesium and some carbonate of lime. When the water is evaporated to dryness, if there is enough carbonate of lime left in the residue to show carbonates, we are inclined to think that water will not corrode boilers, and the same is true even though the carbonates be carbonate of soda, or indeed any other carbonate, so far as our knowledge now goes.

The same thing is true with water containing corrosive sulphates, such as mine drainage. If there is enough of either carbonate of soda or carbonate of lime to leave some carbonates when the water is evaporated to dryness, we are constantly reporting such waters as non-corrosive, and the experience of the service seems to confirm our diagnosis.

Mr. Robert Job (Philadelphia & Reading—by letter):—Circular 42, Water Supply for Steam-making, gives an excellent summary and classification of waters for boiler use. The only change which I should suggest would be in class C, as follows:

Soft Waters.—Those containing a little soluble mineral matter and varying amounts of organic matter. They are good for steam-making and free from injurious results, except when they contain too high a proportion of dissolved gases, such as oxygen (found in very pure mountain streams), or when they contain too much of certain classes of organic matter, peaty water, for instance.

In this section of the country there are a number of water supplies from mountain streams which are of great purity and contain less than one grain residue per gallon, but which have a strong corrosive action upon steel, due to dissolved gases. In such cases a small proportion of caustic soda remedies the difficulty.

REPORT OF COMMITTEE NO. VIII.—ON MASONRY.

To the Members of the American Railway Engineering and Maintenance of Way Association:

The work of your Committee for its fifth annual report has been conducted along the lines laid out by the Board of Direction in Bulletin No. 40.

The first meeting of the Committee was held at Chicago on July 22, 1903, the following members being present: E. C. Brown, Chairman; John Dean, Vice-Chairman; A. O. Cunningham and J. W. Schaub. The subject of "Specifications for sand and tests to be applied to determine quality" was assigned to a sub-committee, consisting of Prof. Geo. F. Swain, M. W. Cooley, C. Lewis and Prof. W. D. Taylor. The subject of "Theory and design for steel concrete" was assigned to Messrs. Cunningham and Schaub.

The second meeting of the Committee was held in Chicago December 2d and 3d, 1903, at which the following members were present: E. C. Brown, Chairman; John Dean, Vice-Chairman; A. O. Cunningham, W. L. Breckinridge and J. W. Schaub. The Committee took final action in approving the present report.

SUMMARY OF CONCLUSIONS CONTAINED IN PREVIOUS REPORTS.

1900: No conclusions or recommendations were made in the report.

1901: The Committee submitted a classification of the different kinds of masonry and subdivision of terms, which were adopted. (See pp. 67, 68, Vol. 2, 1901.)

1902: In the conclusions submitted, the Committee recommended the adoption of the following definition of masonry: "Masonry, in its widest sense, includes all constructions of stone or kindred substitute materials, in which the separate pieces are either placed together, with or without cementing material to join them; or, when not separately placed, are encased in a matrix of firmly cementing material." Also, a recommendation that "it is good practice that railroad companies prepare and use specifications complete in themselves for all kinds of masonry, to be in such form that they may be attached to and form part of specifications and contracts for other railroad construction when desirable." The definition and recommendation were adopted by the convention. (See page 310, Vol. 3, 1902.)

1903: The amended conclusions adopted are as follows: (1) That the definition of masonry terms be received as information and a progress report; (2) That the specifications for Portland and

natural cements be adopted by the Association as a recommended provisional standard; (3) That the specifications for concrete be received as information and a progress report. (See pp. 394, 395, Vol. 4, 1903.)

The sub-committee appointed to take up that part of the work relating to sand, its specifications and use in the testing of cements, recommends that specific action on this subject be deferred until after the final reports of the two committees of other professional societies now considering the subjects are made. One of these is a committee of the American Society of Civil Engineers upon "Uniform Tests for Cement," and the other a committee of the American Society for Testing Materials upon "Standard Cement Specifications." Neither of these committees has yet made a final report, though a progress report of the first-named committee was submitted in January, 1903. In this report the committee recommended the use of "the natural sand from Ottawa, Ill., screened to pass a sieve having twenty (20) meshes per linear inch, and retained on a sieve having thirty (30) meshes per linear inch, the wires to have diameters of 0.0165 and 0.0112-inch, respectively, i. e., half the width of the opening in each case," in place of the crushed quartz formerly specified. It further states that "The Sandusky Portland Cement Company, of Sandusky, Ohio, has agreed to undertake the preparation of this sand, and to furnish it at a price only sufficient to cover the actual cost of preparation." There was at first some difficulty in furnishing this sand of the proper quality, owing partly to inequalities in the wire cloth used for sieves, and partly to the difficulty of securing the proper care and the necessary apparatus required for furnishing large quantities. However, these difficulties are being overcome. Mechanical sieves are being provided, we understand, and every effort is being made to furnish a uniform product. The necessity of uniformity is evident when it is recollected that the voids in a material depend not upon the absolute size of the grains, but upon their shape, and upon the relative proportion of grains of different sizes.

It is therefore recommended by your Committee that we adopt, for the present at least, the standard sand for cement tests and tests recommended by the committee of the American Society of Civil Engineers, with one addition, so that it would read as follows:

The standard sand shall be the natural sand from Ottawa, Ill., screened to pass a sieve having twenty (20) meshes per linear inch, and retained on a sieve having thirty (30) meshes per linear inch; the wires to have diameters of 0.0165 and 0.0112-inch, respectively, i. e., half the width of the opening in each case. The standard shall be considered reached when not over one per cent. passes the No. thirty (30) sieve after one minute of continuous sifting of a sample of 500 grams.

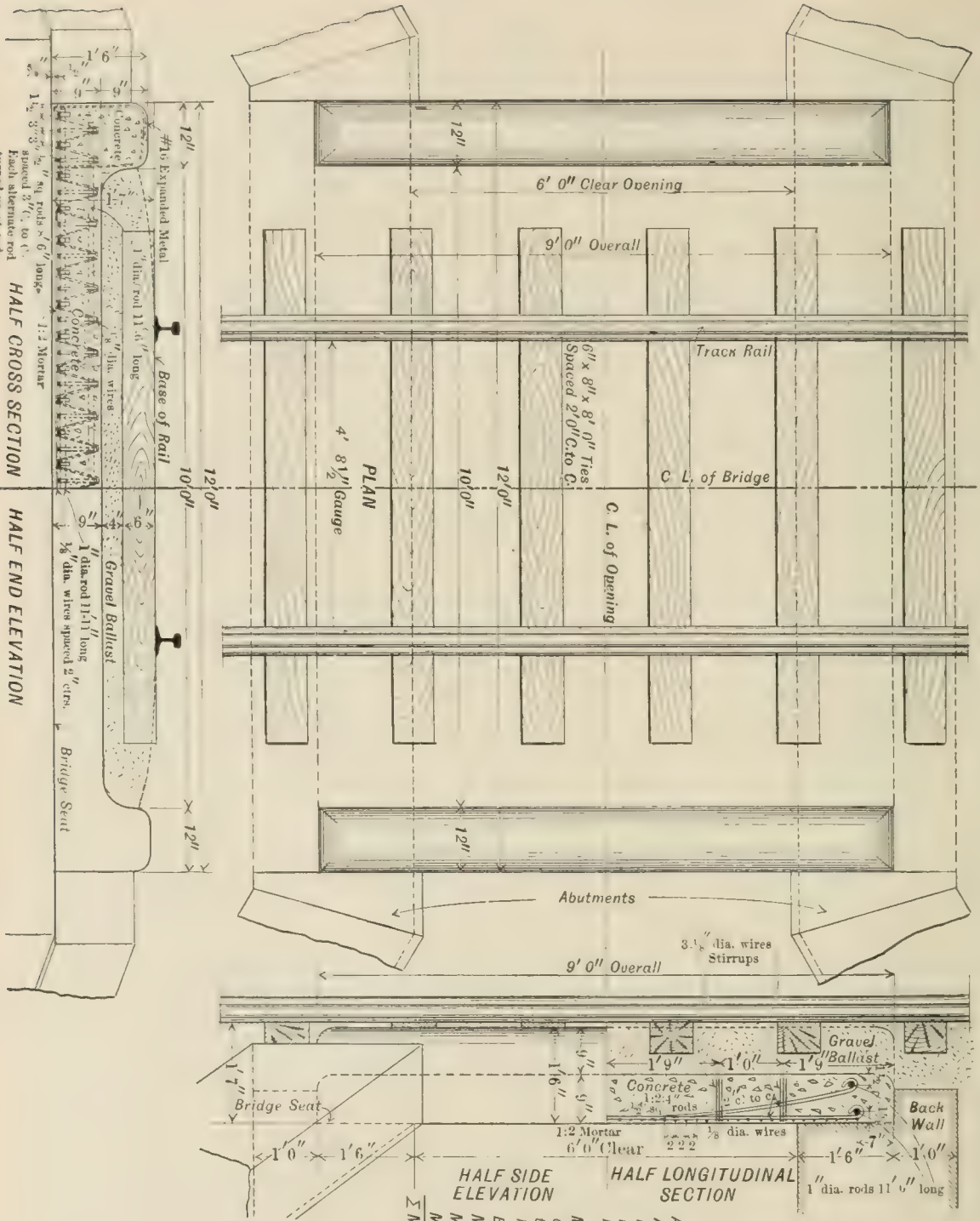
THE THEORY AND DESIGN FOR REINFORCED CONCRETE

Your Committee realizes the scope of its work, and wishes to confine its report, for the present at least, to the theory and design for reinforced beams having a rectangular cross-section, and subject to flexure in one

direction only. Such beams have been tested, and a theory has been evolved by M. Considère in France, which has been revised and improved by Professor Hatt in this country. This theory agrees quite well with experiments made under certain conditions favorable to the theory, whereas under other conditions of loading and design the theory does not apply; in fact, it is a question if the theory of flexure should apply to such cases; or, instead, some new theory which will have to be evolved. In some reinforced beams recently tested, in which the span was short, as compared with the depth of the beams, the metal reinforcement would pull out at the ends, and, at the same time, the beams would fail by shearing without bringing any apparent strain on the metal. In comparing these tests with others made at the same time, in which the span was long, as compared with the depth, in which the metal developed its full tensile strength without slipping, it was suggested that if the metal reinforcement in a beam could in some way be prevented from pulling out at the ends, it would be possible to design a beam of any depth which, upon testing to destruction, would fail by giving way on the tension face. In order to acomplish this, all that was necessary was to anchor the rods at the ends of the beam, when the full tensile strength of the metal could be obtained every time, provided the percentage of metal used did not exceed certain limits. It should be explained that the rods used in all cases were plain rods of medium open-hearth steel, obtained from stock in the open market, and the only requirement to be filled was that they should be capable of bending cold around a radius equal to the thickness of the bar.

Two concrete-steel girders have been built on this plan for the tops of culverts, one having an eight-foot span and the other an eighteen-foot span. In the short span, the ballast under the cross-tie is only four inches deep, so that the effect of impact and vibration from the moving loads should be very marked, and will be watched very carefully. The cut herewith, Fig. 1, shows a design for a girder built on this plan. The longitudinal rods have the ends bent around a transverse rod, the latter forming the anchorage. This is done in the field by bending the rods cold around the nose of an ordinary blacksmith's anvil. This does not require skilled labor, and the lengths of the rods, center to center of eyes, need not be made exact, as the mortar fills up all open spaces in the eyes. It should be explained that the transverse anchor rods serve a double purpose. In addition to their value as an anchorage they are intended to serve as a bond between the longitudinal sections of the concrete, when it becomes necessary, for practical reasons, to lay the concrete in sections, as is usually the case, instead of in one piece.

As to the theory of concrete-steel beams reinforced in this manner, we understand that the entire subject of concrete-steel will be taken up by a committee to be appointed by the American Society of Civil Engineers. This matter will come before the Society at the annual meeting on January 20, 1904. This committee will probably have the means to make some tests which will enable them to establish a satisfactory theory, and, as they will coöperate with any other committee working on this sub-



Assumed fixed load = 1950 lbs. per lin. ft.
Assumed moving load = 62,500 lbs. on 1 axle
D indicates fixed load stress
L " moving " "
I " impact stress $I = L \times \frac{1}{L+D}$

Material is proportioned so as to give a factor of safety of 3 inside the elastic limit of the material, including allowance for impact.

BENDING MOMENT.	END SHEAR.
$M^D = 11,900$ ft lbs.	$S^D = 6,830$ lbs.
$M^L = 54,800$ " "	$S^L = 62,500$ "
$M^I = 45,000$ " "	$S^I = 56,300$ "
$\Sigma M = 111,700$ ft. lbs.	$\Sigma S = 125,630$ lbs.

FIG. 1.—DESIGN FOR REINFORCED CONCRETE GIRDER FOR FLAT-TOP CULVERT.

ject, we suggest that your Committee be instructed to coöperate with them as soon as their committee is appointed.

In the meantime, we recommend that the theory for concrete-steel beams as given by Professor W. K. Hatt be used. (See Engineering News, July 17, 1902.) In order to avoid the tedious computations necessary to design a beam with this theory, we recommend that graphical diagrams be used as given in Engineering News, April 30, 1903.

SPECIFICATIONS FOR PORTLAND CEMENT.

Definition. Portland cement is a product of the mixture of argillaceous and calcareous materials in definite proportions, calcined at a high temperature and reduced to a fine powder.

Packages. Cement shall be packed in well made wooden barrels lined with paper, or in strong cotton or paper sacks. Each package shall be plainly marked with the brand and name of the manufacturer and the net weights shall be exact and uniform.

Weight. One barrel shall contain not less than 376 pounds of cement, and four sacks shall be equivalent in weight to one barrel.

Condition. All cement shall be delivered in sound packages, undamaged by moisture or other causes.

Storage. Cement must be stored until used in a perfectly dry place in such manner as will insure it from all damage.

Rejection. All cement failing to meet the requirements of the specifications may be rejected, and all rejected cement, whether damaged or rejected for other causes, shall be removed at once from the company's property.

Tests. All cement shall be subject to the following tests:

Sampling. (1) The selection of the sample for testing, the number of packages sampled, and the quantity taken from each package, must be left to the discretion of the Engineer, but each sample should be a fair average of the contents of the package from which it is taken. At least one barrel in every ten should be sampled.

(2) Cement in barrels should be sampled through a hole made in the center of one of the staves, midway between the heads, or in the head, by means of an auger, or sampling iron similar to that used by sugar inspectors. If in bags, it should be taken from surface to center.

(3) All samples should be passed through a sieve having twenty meshes per linear inch in order to break up lumps and remove foreign material. For determining the characteristics of a carload of cement the individual samples may be mixed and the average tested; where time will permit, however, each sample will be tested separately.

Fineness. Not less than 94 per cent. of the cement tested shall pass through a No. 100 standard sieve. The standard sieve shall be circular, about 20 cm. (7.87 ins.) in diameter, 6 cm. (2.36 ins.) high, and provided with a pan 5 cm. (1.97 ins.) deep, and a cover. The wire cloth in the sieve to be woven (not twilled) from brass wire, having a diameter of

0.0045 ins. This cloth to be mounted in the frame without distortion; the mesh should be regular in spacing and for a No. 100 sieve shall contain not less than 96 nor more than 100 meshes per linear inch. The cement to be thus tested shall be thoroughly dried at a temperature of 100 C. (212 degrees Fahr.) before sieving.

Set.

(1) Initial set shall not occur in less than thirty (30) minutes.

(2) Final set shall not occur in less than one hour nor more than ten hours.

(3) The time of setting shall be determined by means of the Vicat needle apparatus as recommended by the Committee of the American Society of Civil Engineers upon uniform tests of cement, in conjunction with the Committee of the International Association for Testing Materials.

(4) Using a paste composed of neat cement and water, of normal consistency, the initial set is said to have commenced when the needle ceases to pass a point 5 mm. (0.20 in.) above the upper surface of the glass plate in the Vicat apparatus, and is said to have terminated the moment the needle does not sink visibly into the mass.

(5) The paste is of normal consistency when the cylinder of the Vicat apparatus penetrates to a point in the mass 10 mm. (0.39 in.) below the top of the ring.

(6) The amount of water required to make a paste of normal consistency varies with different cements, but will be found to be approximately 20 per cent. of the weight of the cement. It should have a temperature of 70 degrees Fahrenheit.

Soundness.

Cold Water Test.

(1) A pat of neat cement 2½ to 3 inches in diameter, ½ inch thick at center, tapering to a thin edge, and allowed to take its final set in moist air, must withstand indefinite exposure in water or air at any ordinary temperature without checking, distortion or softening.

Boiling Water Test.

(2) A pat of neat cement as above, placed in water, which shall be slowly raised to the boiling point and then maintained in that condition for three hours and allowed to cool gradually, shall not show any signs of checking, distortion or softening. The same result should follow exposure to steam not under pressure for three hours. This test may or may not be cause for rejection at the option of the Engineer in charge.

Tensile Strength.

(1) The briquette used in testing shall be formed in moulds of the size and form now in customary use and recommended by the American Society of Civil Engineers, the stress to be applied at a uniform rate of 600 pounds per minute until fractured.

(2) All briquettes of neat cement are to be made from paste of normal consistency in the following manner: The moulds should be filled with the paste as soon as it is thoroughly mixed and tempered, the material pressed in firmly with the fingers and smoothed off with a trowel without ramming; the material should be heaped up on the upper surface of the mould, and in smoothing off the trowel should be drawn over the mould in such a manner as to exert a moderate pressure upon the excess material. The mould should then be turned over and the operation repeated upon the other side.

(3) Briquettes for twenty-four hour tests shall be allowed to set twenty-four hours in moist air.

(4) Briquettes for seven and twenty-eight day tests shall be allowed to set one day in moist air and remainder of period in water.

(5) All briquettes are to remain in the water until they are placed in the testing machine, except in the case of twenty-four hour tests.

(6) Neat twenty-four hour tests shall not show less than 125 pounds per square inch. Neat seven day tests shall not show less than 400 pounds per square inch. Neat twenty-eight day tests shall not show less than 500 pounds per square inch, and should show at least 10 per cent. increase above the seven day test.

Sand Test. Briquettes made in the proportions of one (1) part cement to three (3) parts standard sand, after being allowed to set one day in moist air and remainder of period in water, shall not show less than 125 pounds per square inch at seven (7) days, nor less than 200 pounds per square inch at twenty-eight (28) days. The twenty-eight (28) day tests shall show at least 15 per cent. increase above the seven (7) day tests.

Standard Sand. The standard sand shall be the natural sand from Ottawa, Ill., screened to pass a sieve having twenty (20) meshes per linear inch, and retained on a sieve having thirty (30) meshes per linear inch; the wires to have diameters of 0.0165 and 0.0112-inch, respectively, i. e., half the width of the opening in each case. The standard shall be considered reached when not over one (1) per cent. passes the No. 30 sieve after one minute of continuous sifting of a sample of 500 grams.

Specific Gravity. The specific gravity determined upon dried cement which has passed through a No. 100 sieve shall not be less than 3.10 nor more than 3.30. The specific gravity can be conveniently and accurately determined by the use of Le Chatelier's apparatus as recommended by the Committee on uniform tests of cements.

Chemical. Chemical analyses should show not more than 5 per cent. of magnesia, nor more than 1.75 per cent. of sulphuric anhydride.

Uniformity. If in the tests of any given brand of cement, any sudden irregular or wide variation from its normal action is found, it should be withheld from use until more extended tests shall have demonstrated its reliability.

SPECIFICATIONS FOR NATURAL CEMENT.

Definition. Natural cement is a product resulting from the calcination of an argillaceous limestone reduced to a fine powder.

Packages. Cement shall be packed in well made wooden barrels lined with paper, or in strong jute or paper sacks. Each package shall be plainly marked with the brand and name of the manufacturer and the net weights shall be exact and uniform.

Weight. One barrel shall contain not less than 300 pounds of cement. (West of the Alleghany mountains this may be 265 pounds.) Three paper sacks or two jute sacks of cement shall be equivalent in weight to one barrel.

Condition. All cement shall be delivered in sound packages, undamaged by moisture or other causes.

Storage. Cement must be stored until used in a perfectly dry place in such manner as will insure it from all damage.

Rejection. All cement failing to meet the requirements of the specifications may be rejected, and all rejected cement, whether damaged or rejected for other causes, shall be removed at once from the company's property.

Tests. All cement shall be subject to the following tests:

Sampling. (1) The selection of the sample for testing, the number of packages sampled, and the quantity taken from each package, must be left to the discretion of the Engineer, but each sample should be a fair average of the contents of the package from which it is taken. At least one barrel in every ten should be sampled.

(2) Cement in barrels should be sampled through a hole made in the center of one of the staves, midway between the heads, or in the head, by means of an auger or sampling iron similar to that used by sugar inspectors. If in bags, it should be taken from surface to center.

(3) All samples should be passed through a sieve having twenty meshes per linear inch in order to break up lumps and remove foreign material. For determining the characteristics of a shipment of cement the individual samples may be mixed and the average tested; where time will permit, however, each sample shall be tested separately.

Fineness. Not less than 80 per cent. of the cement tested shall pass through a No. 100 standard sieve. The standard sieve shall be circular, about 20 cm. (7.87 ins.) in diameter, 6 cm. (2.36 ins.) high and provided with a pan 5 cm. (1.97 ins.) deep, and a cover. The wire cloth in the sieve to be woven (not twilled) from brass wire, having a diameter of 0.0045 ins. This cloth to be mounted in the frame without distortion; the mesh should be regular in spacing and for a No. 100 sieve shall contain not less than 96 nor more than 100 meshes per linear inch. The cement to be thus tested shall be thoroughly dried at a temperature of 100 C. (212 degrees Fahr.) before sieving.

Set. (1) Initial set shall not occur in less than twenty (20) minutes.

(2) Final set shall not occur in less than forty-five (45) minutes nor more than four (4) hours.

(3) The time of setting shall be determined by means of the Vicat needle apparatus as recommended by the Committee of the American Society of Civil Engineers upon uniform tests of cement, in conjunction with the Committee of the International Association for Testing Materials.

(4) Using a paste composed of neat cement and water, of normal consistency, the initial set is said to have commenced when the needle ceases to pass a point 5 mm. (0.20 ins.) above the upper surface of the glass plate in the Vicat apparatus, and is said to have terminated the moment the needle does not sink visibly into the mass.

(5) The paste is of normal consistency when the cylinder of the Vicat apparatus penetrates to a point in the mass 10 mm. (0.39 ins.) below the top of the ring.

(6) The amount of water required to make a paste of normal consistency varies with different cements, but will be found to be approximately 30 per cent. of the weight of the cement. It should have a temperature of 70 degrees Fahrenheit.

Soundness.

(1) A pat of neat cement 2½ to 3 inches in diameter, ½ inch thick at center, tapering to a thin edge, and allowed to take its final set in moist air, must withstand indefinite exposure in water or air at any ordinary temperature without checking, distortion or softening.

Tensile Strength.

(1) The briquette used in testing shall be formed in moulds of the size and form now in customary use and recommended by the American Society of Civil Engineers, the stress to be applied at a uniform rate of 400 pounds per minute until fractured.

(2) All briquettes of neat cement are to be made from paste of normal consistency in the following manner: The moulds should be filled with the paste as soon as it is thoroughly mixed and tempered, the material pressed in firmly with the fingers and smoothed off with a trowel without ramming; the material should be heaped up on the upper surface of the mould, and in smoothing off the trowel should be drawn over the mould in such a manner as to exert a moderate pressure upon the excess material. The mould should then be turned over and the operation repeated on the other side.

(3) Briquettes for twenty-four hour tests shall remain in moist air until final set has occurred, then be placed in water for remainder of period.

(4) Briquettes for seven and twenty-eight day tests shall be allowed to set one day in moist air and remainder of period in water.

(5) All briquettes are to remain in the water until they are placed in the testing machine.

(6) Neat twenty-four hour tests shall not show less than 60 pounds per square inch. Neat seven day tests shall not show less than 100 pounds per square inch. Neat twenty-eight day tests shall not show less than 150 pounds per square inch, nor less than 25 per cent. above the seven day test.

Sand Test.

Briquettes made in the proportion of one (1) part cement to two (2) parts standard sand, after being allowed to set one day in moist air and remainder of period in water, shall not show less than 80 pounds per square inch at seven (7) days, nor less than 140 pounds per square inch at twenty-eight (28) days. The twenty-eight (28) day tests shall show at least 15 per cent. increase above the seven (7) day tests.

Standard Sand.

The standard sand shall be the natural sand from Ottawa, Ill., screened to pass a sieve having twenty (20) meshes per linear inch, and retained on a sieve having thirty (30) meshes per linear inch; the wires to have diameters of 0.0165 and 0.0112-inch, respectively, i. e., half the width of the opening in each case. The standard shall be considered

reached when not over one (1) per cent. passes the No. thirty (30) sieve after one minute of continuous sifting of a sample of 500 grams.

Specific Gravity. The specific gravity determined upon dried cement which has passed through a No. 100 sieve shall not be less than 2.50 nor more than 2.80. The specific gravity can be conveniently and accurately determined by the use of Le Chatelier's apparatus as recommended by the Committee on uniform tests of cements.

Uniformity. If in the tests of any given brand of cement, any sudden irregular or wide variation from its normal action is found, it should be withheld from use until more extended tests shall have demonstrated its reliability.

SPECIFICATIONS FOR PORTLAND CEMENT CONCRETE.

Cement. Cement shall be Portland, either American or Foreign, which will meet the requirements of the standard specifications.

Sand. Sand shall be clean, sharp, coarse, and of grains varying in size. It shall be free from sticks and other foreign matter, but it may contain clay or loam not to exceed five (5) per cent. Crusher dust, screened to reject all particles over one-quarter inch in diameter, may be used instead of sand if approved by the Engineer.

Stone. Stone shall be sound, hard and durable, crushed to sizes not exceeding two inches in any direction. For reinforced concrete sizes usually are not to exceed three-quarter-inch in any direction, but may be varied to suit character of reinforcing material.

Gravel. *Gravel shall be composed of clean pebbles of hard and durable stone of sizes not exceeding two inches in diameter, free from clay and other impurities except sand. When containing sand in any considerable quantity, the amount per unit of volume of gravel shall be determined accurately to admit of the proper proportion of sand being maintained in the concrete mixture.

Water. Water shall be clean and reasonably clear, free from sulphuric acid or strong alkalies.

Mixing by Hand. (1) Tight platforms shall be provided of sufficient size to accommodate men and materials for the progressive and rapid mixing of at least two batches of concrete at the same time. Batches shall not exceed one cubic yard each, and smaller batches are preferable, based upon a multiple of the number of sacks to the barrel.

(2) Spread the sand evenly upon the platform, then the cement upon the sand and mix thoroughly until of an even color. Add all the water necessary to make a thin mortar and spread again; add the gravel if used, and finally the broken stone, both of which, if dry, should first be thoroughly wet down. Turn the mass with shovels or hoes until thoroughly incorporated, and all the gravel and stone is covered with mortar; this will probably require the mass to be turned four times.

(3) Another approved method, which may be permitted at the option of the Engineer in charge, is to spread the sand, then the cement and

*See amendments, pp. 618, 619.

mix dry, then the gravel or broken stone; add water and mix thoroughly as above.

Mixing by Machine.

*A machine mixer shall be used wherever the volume of work will justify the expense of installing the plant. The necessary requirements for the machine will be that a precise and regular proportioning of materials can be controlled and the product delivered be of the required consistency and thoroughly mixed.

Consistency.

*The concrete shall be of such consistency that when dumped in place it will not require much tamping. It shall be spaded down and tamped sufficiently to level off, after which the water should rise freely to the surface.

Forms.

(1) Forms shall be well built, substantial and unyielding, properly braced or tied together by means of wire or rods, and shall conform to lines given.

*(2) For all important work the material used shall be dressed lumber, sound and free from loose knots, secured to the studding or uprights in horizontal lines.

(3) For backings and other rough work undressed lumber may be used.

(4) Where corners of the masonry and other projections liable to injury occur, suitable mouldings shall be placed in the angles of the forms to round or bevel them off.

*(5) Planking once used in forms shall be cleaned before being used again.

(6) The forms must not be removed within thirty-six hours after all the concrete in that section has been placed. In freezing weather they must remain until the concrete has had a sufficient time to become thoroughly set.

(7) In dry but not freezing weather, the forms shall be drenched with water before the concrete is placed against them.

Disposition.

(1) Each layer should be left somewhat rough to insure bonding with the next layer above; and, if it be already set, shall be thoroughly cleaned and scrubbed with coarse brushes and water before the next layer is placed upon it.

*(2) Concrete shall be deposited in the moulds in layers of such thickness as shall be specified by the Engineer in charge. It must, however, be spread in layers at right angles to the lines of pressure, and temporary planking placed at ends of partial layers, so that none shall run out to a thin edge. Excepting in arch work, all concrete must be deposited in horizontal layers of uniform thickness throughout. The ends, where a full layer can not be laid at the time, shall be squared off by vertical temporary planking.

*(3) The work should be carried up in sections of convenient length and the sections completed without intermission.

(4) In no case shall work on a section stop within 18 inches of the top.

*See amendments, pp. 618, 619.

(5) Concrete shall be placed immediately after mixing and any having an initial set shall be rejected.

Expansion Joints.

*(1) In exposed work expansion joints may be provided at intervals of fifty to one hundred feet or as the Engineer may direct.

*(2) A temporary vertical form or partition of plank shall be set up and the section behind completed as though it were the end of the structure. The partition will be removed when the next section is begun and the new concrete placed against the old without mortar flushing. Locks shall be provided if directed or called for by the plans.

(3) In reinforced or steel concrete the length of these sections may be materially increased at the option of the Engineer.

Facing.

*(1) A shovel facing may be made by carefully working the coarse stone back from the form by means of a shovel or spade so as to bring the excess mortar of the concrete to the face. Or,

*(2) About one inch of mortar (not grout) of the same proportions as used in the concrete shall be placed next to the forms immediately in advance of the concrete.

*(3) Care must be taken to remove from the forms the dried mortar which spatters against them, in order to secure a perfect face.

Proportioning

The proportion of the materials in the concrete shall be as specifically called for by the contract, or as set forth herein, upon the lines left for that purpose; the volume of cement to be based upon the actual cubic contents of one barrel of specified weight.

STRUCTURE.	Parts by Volume			
	Cement	Sand	Gravel	Broken Stone

*See amendments, pp. 618, 619.

Finishing.

*(1) After the forms are removed, which should generally be as soon as possible after the concrete is sufficiently set, any small cavities or openings in the face shall be neatly filled with mortar if necessary. Any ridges due to cracks or joints in the lumber shall be rubbed down with chisel or wooden float. The entire face may then be washed with a thin grout of the consistency of whitewash, mixed in the same proportion as the mortar of the concrete. The wash should be applied with a brush. The earlier the above operations are performed the better will be the result.

*(2) The tops of bridge seats, pedestals, copings, wing walls, etc., when not finished with natural stone coping, shall be finished with a smooth surface composed of one part cement to two parts of granite, or other suitable screenings, or sand applied in a layer ½ to 1 inch thick. This MUST be put in place with the last course of concrete.

Water-proofing.

*A thin coat of mortar or grout shall be applied for a finishing coat, upon which shall be placed a suitable covering of asphalt.

Freezing Weather.

Ordinarily concrete to be left above the surface of the ground will not be constructed in freezing weather. Portland cement concrete, however, may be built under these conditions by special instructions. In this case the sand, water and broken stone shall be heated, and in severe cold salt shall be added in the proportion of about 2 lbs. per cubic yard.

Reinforced Concrete.

*Where concrete is deposited in connection with metal reinforcing, the greatest care must be taken to insure the coating of the metal with cement, and the thorough compacting of the concrete around the metal. Wherever it is practicable the metal should be placed in position first. This can usually be done in the case where the metal occurs in the bottoms of the forms, by supporting the same on transverse wires, or otherwise, when the bottoms of the forms can be flushed with cement mortar, so as to get the mortar under the metal at the same time, and the concrete deposited immediately afterward. The mortar for flushing the bars should be composed of one part cement and two parts sand. The metal used in the concrete shall be free from dirt, oil or grease. Rust is not objectionable, but all mill scale should be removed by hammering the metal, or preferably by pickling the same in a weak solution of muriatic acid. No reinforced concrete shall be laid in freezing weather.

*See amendments, pp. 618, 619.

DEFINITIONS OF MASONRY TERMS APPLIED TO RAILROAD CONSTRUCTION.

MASONRY.

MASONRY.—All constructions of stone or kindred substitute materials in which the separate pieces are either placed together, with or without cementing material to join them, or where not separately placed, are encased in a matrix of firmly cementing material.

CLASSIFICATION OF MASONRY.

Kinds of Masonry	Sub-division into Classes of Material	Manner of Work	Dressing	Face or Surface Finish
Stone	Dimension	In courses	Fine-pointed Crandalled Axed or Peen-hammered Tooth-axed Sawed Rubbed	Quarry-faced Pitch-faced Drafted
	Arch	In courses	Fine-pointed Crandalled Axed or Peen-hammered	
	Ashlar	Range Broken Range	Tooth-axed Sawed	
	Squared Stone	Range Broken Range Random	Rough-pointed Fine-pointed Crandalled	
	Rubble	Coursed Uncoursed	None	Quarry-faced
	Dry	No mortar	May be any of the above	May be any of the above
Concrete	Broken Stone Gravel Other material			
Brick	Face No. 1 Paving No. 2 " Common	English Bond Flemish "		

Riprapping and Paving are not masonry construction.

DIMENSION STONE.—A block of stone cut to specified dimensions.

COPING.—A top course of stone or concrete, generally slightly projecting, to shelter the masonry from the weather, or to distribute the pressure from exterior loading.

ARCH MASONRY.—That portion of the masonry in the arch ring only, or between the intrados and the extrados.

ASHLAR MASONRY.—Masonry built of ashlar blocks.

RANGE MASONRY.—Masonry in which the various courses are laid up with continuous horizontal beds.

BROKEN RANGE MASONRY.—Masonry in which the bed joints are parallel but not continuous.

SQUARED-STONE MASONRY.—Masonry in which the stones are roughly squared and roughly dressed on beds and sides.

RUBBLE MASONRY.—Masonry composed of squared or roughly squared stones, or rubble of irregular size or shape.

DRY WALL.—A masonry wall in which stones are built up without the use of mortar.

CONCRETE.

CONCRETE.—A compact mass of broken stone, gravel or other suitable material assembled together with cement mortar and allowed to set.

RUBBLE CONCRETE.—Concrete in which rubblestone are imbedded.

REINFORCED CONCRETE.—Concrete which has been reinforced by means of metal in some form, so as to give the concrete elasticity and increased strength.

BRICK.

BRICK.—No. 1.—Hard burned brick, absorption 2 per cent. by weight.

BRICK.—No. 2.—Softer and lighter brick than No. 1, absorption 5 to 6 per cent. by weight.

CEMENT.

CEMENT.—A preparation of calcined clay and limestone, or their equivalents, possessing the property of hardening into a solid mass when moistened with water. This property is exercised under water, as well as in open air. Cements are divided into three classes: Portland, Natural and Puzzolan. (See each.)

PORTLAND CEMENT.—A product of the mixture of argillaceous and calcareous materials, in definite proportions, calcined at a high temperature and afterwards reduced to a fine powder. It possesses the quality of hardening either in air or under water when mixed into a paste.

NATURAL CEMENT.—A product resulting from the calcination of argillaceous limestone reduced to a fine powder. It possesses the property of hardening either in air or under water when mixed into a paste.

PUZZOLAN.—An intimate mixture of ground furnace slag and slaked lime without further calcination which possesses the hydraulic qualities of cement.

SILICA CEMENT (SAND CEMENT).—A mixture of clean sand and Portland cement ground together.

DESCRIPTIVE WORDS.

ARRIS.—An external angle, edge or ridge.

ASHLAR.—A squared or cut block of stone with rectangular dimensions.

AXED.—Dressed so as to cover the surface of a stone with chisel marks which are nearly or quite parallel.

BACKING.—That portion of a masonry wall or structure built in the rear of the face. It must be attached to the face and bonded with it. It is usually of a cheaper grade of masonry than the face.

BATTER.—The slope or inclination of the face from a vertical line.

BED.—The top and bottom of a stone. (See Course Bed; Natural Bed; Foundation Bed.)

BED JOINT.—A horizontal joint, or one perpendicular to the line of pressure.

BETON.—(See Concrete.)

BLOCK RUBBLE.—Large blocks of building stone as they come from the quarry. (See Rubble.)

BOND.—The mechanical disposition of stone, brick or other building blocks by over-lapping to break joints.

BUILD.—A vertical joint.

BUSH-HAMMERED.—A surface produced by removing the roughness of stone with a bush-hammer.

CENTERING.—A temporary support used in arch construction. (Also called Centers.)

COURSE.—Each separate layer in stone, concrete or brick masonry.

COURSE BED.—Stone, brick or other building material in position, upon which other material is to be laid.

CRANDALLED.—Dressed with a crandalling tool, producing the same effect as fine-pointed.

DRAFT.—A line on the surface of a stone cut to the breadth of the chisel.

DRAFTED STONES.—Stones on which the face is surrounded by a draft, the space inside the draft being left rough.

DRESSING.—The finish given to the surface of stones or to concrete.

EXPANSION JOINT.—A vertical joint or space to allow for temperature changes.

EXTRADOS.—The upper or convex surface of an arch.

FACE.—The exposed surface in elevation.

FACING.—In concrete: (1) A rich mortar placed on the exposed surfaces to make a smooth finish.

(2) Shovel facing by working the mortar of concrete to the face.

FINAL SET.—A stage of the process of setting marked by certain hardness. (See Cement Specifications.)

FINE POINTED.—Dressed by fine point to smoother finish than by rough point.

FLUSH.—(Adj.) Having the surface even or level with an adjacent surface.

(Verb.) (1) To fill. (2) To bring to a level. (3) To force water to the surface of mortar or concrete by compacting or ramming.

FOOTING.—A projecting bottom course.

FORMS.—Temporary structures for holding concrete in desired shape.

FOUNDATION.—(1) That portion of a structure, usually below the surface of the ground, which distributes the pressure upon its support.

(2) Also applied to the natural support itself; rock, clay, etc.

FOUNDATION BED.—The surface on which a structure rests.

GROUT.—A thin mortar either poured or applied with a brush.

*HEADER.—A stone which has its greatest length at right angles to the face of the wall, and which bonds the face stones to the backing.

INITIAL SET.—An early stage of the process of setting, marked by certain hardness. (See Cement specifications.)

INTRADOS.—The inner or concave surface of an arch.

*Definition added by Committee since convention.

JOINT.—The narrow space between adjacent stones, bricks or other building blocks, usually filled with mortar.

LAGGING.—Strips used to carry and distribute the weight of an arch to the ribs or centering during its construction.

LEVELLER.—A small rectangular stone, not less than 4 to 6 inches thick, used in broken range work to complete the bed for a stone in the course above and give it proper bond. Sometimes called jumper or dutchman.

LOCK.—Any special device or method of construction used to secure a bond in the work.

MORTAR.—A mixture of sand, cement or lime, and water, used to cement the various stones or brick in masonry or to cover the surface of same.

NATURAL BED.—The surfaces of a stone parallel to its stratification.

PAVING.—Regularly placed stone or brick forming a floor.

PEAN-HAMMERED.—(See Axed.)

PINNER.—A spall or small stone used to wedge up a stone and give it better bearing.

PITCHED-FACED.—Having the arris clearly defined by a line beyond which the rock is cut away by the pitching chisel so as to make approximately true edges.

POINTING.—Filling joints or defects in the face of masonry structure.

QUARRY-FACE.—Stone faced as it comes from the quarry.

RANDOM RANGE MASONRY.—(See Broken Range Masonry.)

RIPRAP.—Rough stone of various sizes placed compactly or irregularly to prevent scour by water.

ROUGH POINTED.—Dressed by pick or heavy point until the projections vary from ½ inch to one inch.

RUBBED.—A fine finish made by rubbing with grit or sandstone.

RUBBLE.—Field stone or rough stone as it comes from the quarry. When it is of large or massive size it is termed block rubble.

SET (Noun).—The change from a plastic to a solid or hard state.

*SOFFIT.—The under side of a projection.

SPALL (Noun).—A chip or small piece of stone broken from a large block.

STEEL CONCRETE.—Masonry reinforced by imbedding within it steel beams, rods, wires or expanded sheets in various forms. (See Reinforced Concrete.)

*STRETCHER.—A stone which has its greatest length along the face of the wall.

TOOTH-AXED.—Dressed by a method of fine pointing.

VOUSSOIRS.—The stones, blocks of concrete or other material forming the arch ring.

CONCLUSIONS.

In conclusion your Committee recommends:

1. That the definitions of Masonry terms be adopted by the Association.

2. That the specifications for Portland and Natural cements be adopted by the Association and used by its members as their standard

*Definition added by Committee since convention.

specifications until such time as proper investigation indicate a change to be desirable.

3. That the specifications for concrete be adopted as standard by the Association.

Respectfully submitted,

E. C. Brown, *Chairman;* Engineer Maintenance of Way, Union Railroad, Port Perry, Pa.

John Dean, *Vice-Chairman;* Civil Engineer, Chicago, Ill.

W. L. Breckinridge, Chief Engineer, Chicago, Burlington & Quincy Railroad, Chicago, Ill.;

C. W. Boynton, Cement Inspector, Baltimore & Ohio Railroad, Wheeling, W. Va.;

A. O. Cunningham, Bridge Engineer, Wabash Railroad, St. Louis, Mo.

C. Lewis, Civil Engineer, New York, N. Y.;

J. W. Schaub, Consulting Engineer, 1650 Monadnock Block, Chicago, Ill.

G. F. Swain, Prof. of Civil Engineering, Mass. Inst. of Technology, Boston, Mass.;

W. D. Taylor, Professor of Railroad Engineering, University of Wisconsin, Madison, Wis.

Committee.

AMENDMENTS.

Gravel shall be composed of clean pebbles of hard and durable stone of sizes not exceeding 2 inches in diameter, and shall be free from clay and other impurities except sand. When containing sand in any considerable quantity, the amount of sand per unit of volume of gravel shall be determined accurately, to admit of the proper proportion of sand being maintained in the concrete mixture.

Mixing by Machine.—A machine mixer shall be used wherever the volume of work will justify the expense of installing the plant. The necessary requirements for the machine will be that a precise and regular proportioning of materials can be controlled and that the product delivered shall be of the required consistency and thoroughly mixed.

Consistency.—The concrete shall be of such consistency that when dumped in place it will not require much tamping. It shall be spaded down and tamped sufficiently to level off, and the water should rise freely to the surface.

Forms.—(2) For all important work, the lumber used for face work shall be dressed on one side and both edges to a uniform thickness and width, and shall be sound and free from loose knots, secured to the studding or uprights in horizontal lines.

(5) Lumber once used in forms shall be cleaned before being used again.

Disposition.—(2) Concrete shall be deposited in the molds in layers of such thickness and position as shall be specified by the engineer in charge. Temporary planking shall be placed at ends of partial layers, so that none shall run out to a thin edge. In general, excepting in arch work, all concrete must be deposited in horizontal layers of uniform thickness throughout.

(3) The work shall be carried up in sections of convenient length and each section completed without intermission.

Expansion Joints.—(1) In exposed work, expansion joints may be provided at intervals of 30 to 100 feet, as the character of the structure may require.

(2) A temporary vertical form or partition of plank shall be set up and the section behind completed as though it were the end of the structure. The partition shall be removed when the next section is begun, and the new concrete placed against the old without mortar flushing. Locks shall be provided if directed or called for by the plans.

Facing.—(1) The facing will be made by carefully working the coarse material back from the form by means of a shovel, bar or similar tool, so as to bring the excess mortar of the concrete to the face.

(2) About one inch of mortar (not grout) of the same proportions as used in the concrete may be placed next to the forms immediately in advance of the concrete.

(3) Care must be taken to remove before filling from the forms dry mortar, in order to secure a perfect face.

Finishing.—(1) After the forms are removed, which should generally be as soon as possible after the concrete is sufficiently set, any small cavities or openings in the face shall be neatly filled with mortar, if necessary in the opinion of the engineer. Any ridges due to cracks or joints in the lumber may be rubbed down with chisel or wooden float. The entire face may then be washed with a thin grout of the consistency of whitewash, mixed in the same proportion as the mortar of the concrete. The wash should be applied with a brush. The earlier the above operations are performed the better will be the result.

(2) The tops of bridge seats, pedestals, copings, wing walls, etc., when not finished with natural stone coping, shall be finished with a smooth surface composed of one part cement to two parts of granite, or other suitable screenings, or sand applied in a layer ½ to 1 inch thick. This must be put in place with the last course of concrete.

Waterproofing.—Where waterproofing is required, a thin coat of mortar or grout shall be applied for a finishing coat, upon which shall be placed a covering of suitable waterproofing material.

Reinforced Concrete.—Where concrete is deposited in connection with metal reinforcing, the greatest care must be taken to insure the coating of the metal with cement, and the thorough compacting of the concrete around the metal. Wherever it is practicable the metal should be placed in position first. This can usually be done in the case where the metal occurs in the bottoms of the forms, by supporting the same on transverse wires, or otherwise, when the bottoms of the forms can be flushed with cement mortar, so as to get the mortar under the metal at the same time, and the concrete deposited immediately afterward. The mortar for flushing the bars should be composed of one part cement and two parts sand. The metal used in the concrete shall be free from dirt, oil or grease. All mill scale should be removed by hammering the metal, or preferably by pickling the same in a weak solution of muriatic acid. No salt will be used in reinforced concrete when laid in freezing weather.

APPENDIX.

STRENGTH OF REINFORCED CONCRETE BEAMS.

By W. K. Hatt, Professor of Applied Mechanics, Purdue University.

Since the Committee on Masonry has referred to the theory advanced by the writer to account for the strength of reinforced concrete beams, he wishes to go a step farther and make more clear his exact position in relation to this matter, particularly since some of his original conclusions have been extended by others to apply to cases not contemplated by the writer. He therefore presents the following:

(1) A short account of his experiments.
(2) Equations of flexure in Appendix I.
(3) Diagrams representing equations.
(4) A simple formula.

The writer has been conducting experiments in which he has been assisted by students in the School of Civil Engineering, to determine the proper method of analysis of the strength of a combination of steel and concrete under flexure. He has been concerned chiefly with experiments which would serve to test the validity of this analysis. For this purpose it was necessary to use uniform materials of a high quality. The experiments were therefore conducted on beams made of rich concrete and reinforced with plain bars without any bond other than natural adhesion between the cement and the steel. In the construction of the beams the proportion of the steel was so modified and so placed in various portions of the cross-section as to create a variety of conditions, in order that the flexibility of the theory might thus be tested. The concrete represented good arch-ring concrete. No attempt was made to develop those weaknesses which at times result in particular kinds of failure in certain forms of practical construction. Accompanying the writer's tests on beams have been tests on steel and on concrete, both in tension and compression.

It is no part of the writer's present purpose to reproduce the algebraic work back of the equations referred to by the Committee. The original paper may be found in the Transactions of the American Society for Testing Materials, Vol. 11, page 161, and in the Engineering News, July 17, 1902. The equations are here reproduced in Appendix I. Figs 1, 2 and 6 are taken from the references cited. The theory takes account of that part of the bending moment due to tensional forces in the concrete, and it supposes a parabolic law of variation of the stress in the concrete of the beam with the distance from the neutral axis.

The tests were on beams 8x8 in. in cross-section, made of 1-2-4 con-

crete. The stone was limestone, crusher run below one inch. The proportions were by loose volume. The beams were tested under a center load on an 80-in. span. The tests have disclosed the following facts:

(1) The flexibility of reinforced concrete beams, that is, the degree of deflection before cracks, visible to the naked eye, are formed in the lower part of the beam, is about ten times that of a beam without reinforcement. This observation checks Considère's results, who found that reinforced concrete would, without cracking, submit to an extension at least ten times that ordinarily experienced by plain concrete. The benefit of this increased flexibility is that thereby the strength of the steel in tension and the strength of the concrete in compression may be largely utilized. The strength of a beam reinforced with steel rods whose cross-section constituted 2 per cent. of the cross-section of the beam was from four to five times that of a plain concrete beam. In fact, beams may be designed in which factors of safety in all the three elements, that is, steel in tension, concrete in compression and tension, may be very nearly equal. Steel of an especially high elastic limit is needed, however, to develop the compressive strength of 1-2-4 concrete.

(2) In the presence of this 1-2-4 concrete the first visible failure was a tension crack in the concrete near the center of the beam. The failure was not due to a slipping of these plain bars in the surrounding concrete nor to the effects of shear. Beams tested on a 40-in. span yielded similar tension cracks. In certain further tests, however, made on leaner concretes, 1-3-6, failure has been due to a pulling out of the bar from the concrete near the end of the beam. Accompanying this pulling out was a crack in the beam running up from the support toward the load. This latter crack is sometimes called a shear crack, but is really due to tensional stresses, which are the resultant of internal shears and longitudinal stress. The value of some mechanical bond or of some form of stirrup or abutment in such cases will be evident. The only failure purely of the nature of a shear is the separation which sometimes occurs in a horizontal plane just above the reinforcement. This latter separation has only occurred in the writer's experience in a beam which was so highly over-reinforced that there was very little concrete between the steel bars.

It may be noted that the writer's tests were under conditions of concentrated loading, and that failure near the end of a beam due to shear would be more likely under uniform loading, since for the same center moment the shear is double under a condition of uniform load as compared to concentrated loading. The value of the vertical shear per square inch of cross-section of the beam tested by the writer was on the maximum about 160 pounds per square inch. The resultant of two shears at right angles to each other is a tension of the same amount, and this might easily rupture ordinary concrete. The tensile strength of the concrete in the 1-2-4 beams was nearly 300 pounds per square inch. The adhesion between the steel and concrete was about 700 lbs. per sq. in. of surface.

After the first visible crack is formed in tension, it spreads upward.

Then the strength of the steel in tension and the concrete in compression is brought into play. The higher the elastic limit of the steel the more one postpones the point of rapid increase of the width of this crack, and when steel is used of sufficiently high elastic limit, and in sufficient quantity, the compressive strength of the concrete in the upper flange will be developed. In the writer's tests of stone concrete beams reinforced with wrought iron, whose elastic limit was 36,000 pounds per square inch, a 2 per cent. reinforcement failed to develop the compressive strength of the concrete.

In no tests either with 1-2-4 concrete beams or 1-5 gravel concrete beams reinforced with less than 2 per cent. of metal of a low elastic limit has the first visible failure been other than a crack in tension at the center

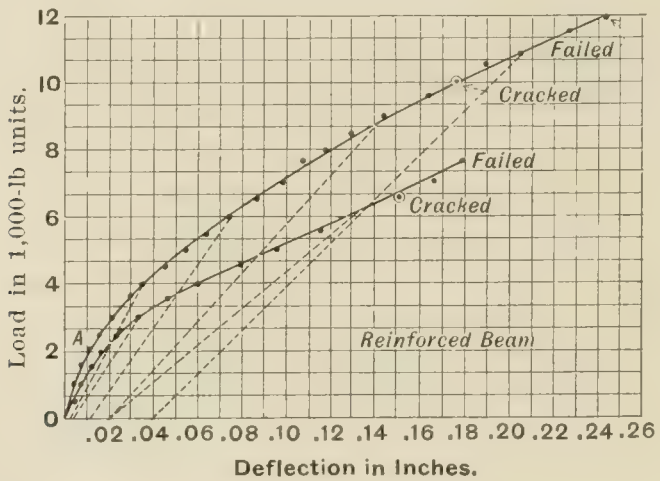


Fig. 1.

of the beam. The above remarks also apply to tests of 1-5 gravel concrete beams of similar size and loading.

(3) The behavior of the reinforced concrete beams under flexure was as shown in Fig. 1 below. It will be noticed that the ratio between load and deflection remains very nearly constant up to point A, which is one-half to one-third the maximum strength. The diagram then becomes of less inclination to the deflection axis and the deflection proceeds until a crack visible to the naked eye appears in the tension side of the beam and a deflection of about one five-hundredth part of the span. In the case of gravel concrete beams the maximum load coincides with the load at first crack, and the diagram beyond the point A has a decided curvature.

It is probable that at point A there are minute cracks invisible to the naked eye, and the writer understands that certain observers have recently observed these minute cracks. These are explained by the following considerations: When a piece of plain concrete is pulled in tension the first minute crack which forms is afterward rapidly developed

into a plane of rupture; but when the same concrete bar is reinforced with steel rods the spreading of this minute crack is prevented, with the consequence that the concrete bar cracks in a number of places throughout the entire length, and that the extension at the time of failure is much greater than that extension experienced by a plain bar at the time of failure. Thus, Considère has found, and his tests have been checked by the writer, that plain concrete in tension experiences an extension at the time of rupture of only one-tenth that experienced by reinforced concrete. In other words, the steel acts as does hair in plaster.

A diagram representing a test of reinforced concrete in tension is shown below, Fig. 2.

In the case of a reinforced concrete bar under tension we may suppose that these minute cracks begin to form at a point, P, preceding the rapid increase in elongation in Fig. 2, but no one of these minute cracks spreads to form a visible crack until the further extension of the bar.

It does not seem that these minute cracks are of any practical con-

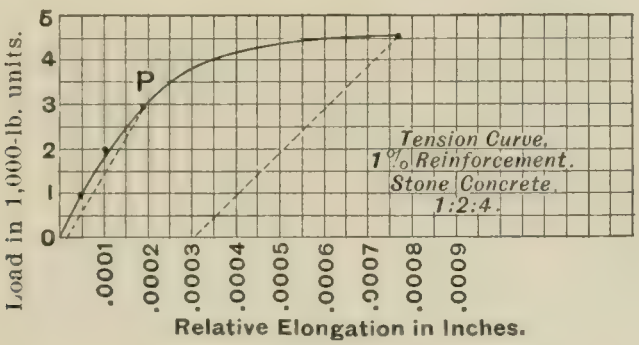


Fig. 2.

sequence. The crack which is called by the writer "first crack" is a crack visible to the naked eye, such as would be an evidence of weakness in an actual structure.

(4) Results of tests indicate that reinforcement in the compression flange adds but little to the resisting moment.

The writer has advanced a theory to account for these three points, A, first crack, and maximum strength, and finds the theory is flexible enough to predict the behavior of a beam at various stages of the test when such beam is reinforced with different percentages of metal placed at different parts of the cross-section. The equations of the theory are complicated and difficult of computation, but that part of the expression for bending moment in brackets, in Eq. (5), Appendix, may be represented graphically or may be replaced with a simple formula which may be called the "Straight Line Formula for Reinforced Concrete Beams." While these equations are complicated, they approach so nearly the straight line that for ordinary degrees of reinforcement the straight line will serve all purposes. The writer proceeds to give this Straight Line Formula to

cover the tests so far made, and he also presents a diagram which shows the nature of the equations in more elaborate theory.

Straight Line Formula.

$M = Ktbh^2$

Where M = Moment in inch pounds.

p = percentage of steel in cross-section in lower flange (not to exceed 3).

b = breadth of beam in inches.

h = depth of beam in inches.

t = tensile strength of concrete in pounds per sq. in.

u = the fractional depth of the steel from the top of the beam.

K = a constant which is as follows:

For 1-2-4 stone-concrete beams:

$K = [\frac{1}{3} + (\frac{7}{4} u - 1) p]$

Or $M = [\frac{1}{3} + (\frac{7}{4} u - 1) p] tbh^2$

For 1-5 gravel-concrete when $u = \frac{7}{8}$.

$M = (\frac{1}{3} + \frac{3}{4} p) tbh^2$

The value of t may be taken as one-tenth the crushing strength in the case of stone-concrete, and one-ninth the crushing strength in the case of gravel-concrete. This fact has been determined by actual tests made by the writer. The following values have been derived by his tests: See Table I.

The use of this formula must be followed by a computation of the srtesses in concrete in compression and steel in tension; otherwise a per-cent. of steel may be taken which would call for too high values of the strength of the concrete in compression. The computation is best performed by the diagrams mentionel below.

The question as to the proper point at which factors of safety should be fixed is of practical consequence. Either the point of appearance of the first visible crack or the ultimate load may be taken. In certain designs, however, this ultimate load corresponds to a state of failure which is very far advanced and very much beyond the point of the first visible crack.

ILLUSTRATIONS OF THE USE OF THE FORMULA.

Find the strength of a beam 8x8 in. in cross-section reinforced with 2 per cent. of steel, made of 1-2-4 stone-concrete, 28 days old. The center of the steel is one inch above the bottom of the beam. Assume t = 280 pounds.

$u = \frac{7}{8}$.

$M = bh^2\ 280\ (.333 + 0.55p)$.

If p = 2 per cent

$M = bh^2\ 401$.

If a beam is 8x8 in. in cross-section

M = 205,312 inch-pounds.

If the span of the beam is 80 in., the center load

= P = 10,260 pounds.

A beam tested under these conditions gave 10,250 pounds load. The safe load would be about 3,400 pounds.

For use in rough calculations it may be well to state the following rule:

The resisting moment of beams one month old may be put,
$M = K'bh^2$
Units, inches and pounds.
The value of K′ at the age of one month is as follows:
1-2-4 crusher run below 1 inch.

Per cent. of steel	K′
0	90
1	250
2	400
1-5 Gravel	
1	280
2	480

That is to say, the resisting moment of a reinforced concrete beam with 1 per cent. of steel is 250 times the width times the square of the height. The beams would show a visible crack on the application of this bending moment when soft steel is used.

USE OF A DIAGRAM.

The writer, assisted by Mr. C. H. Hall, Purdue, 1903, has plotted in Figs. 3 and 4 two diagrams.

Figs. 3 and 4 enable the strength of beams to be computed when made of different kinds of concrete reinforced with different percentages of steel. They enable a simple formula to be used of the following nature:

$M = Ktbh^2$
Where M = Bending Moment in inch-pounds.
b = width of beam in inches.
h = depth of beam in inches.
t = tensional strength of the concrete.
K is a constant which depends on per cent. of reinforcement and kind of concrete.

Fig. 3 enables the bending moment to be computed at point A. Fig. 4 enables this bending moment to be computed at the point of first visible crack. The writer desires to say that the lines on these diagrams are simple expressions of equations in Appendix I, resulting from the application of the theoretical analysis and they are not to be used with any practical operations until the experimental points have been located on the diagram, to establish the application of these lines to practical conditions.

As has been said, the writer has been working to establish the experimental points on these diagrams. Up to the present time his experiments cover the field represented by the lower lines in the diagram. He has shown so far that the theory is elastic enough to predict the strength

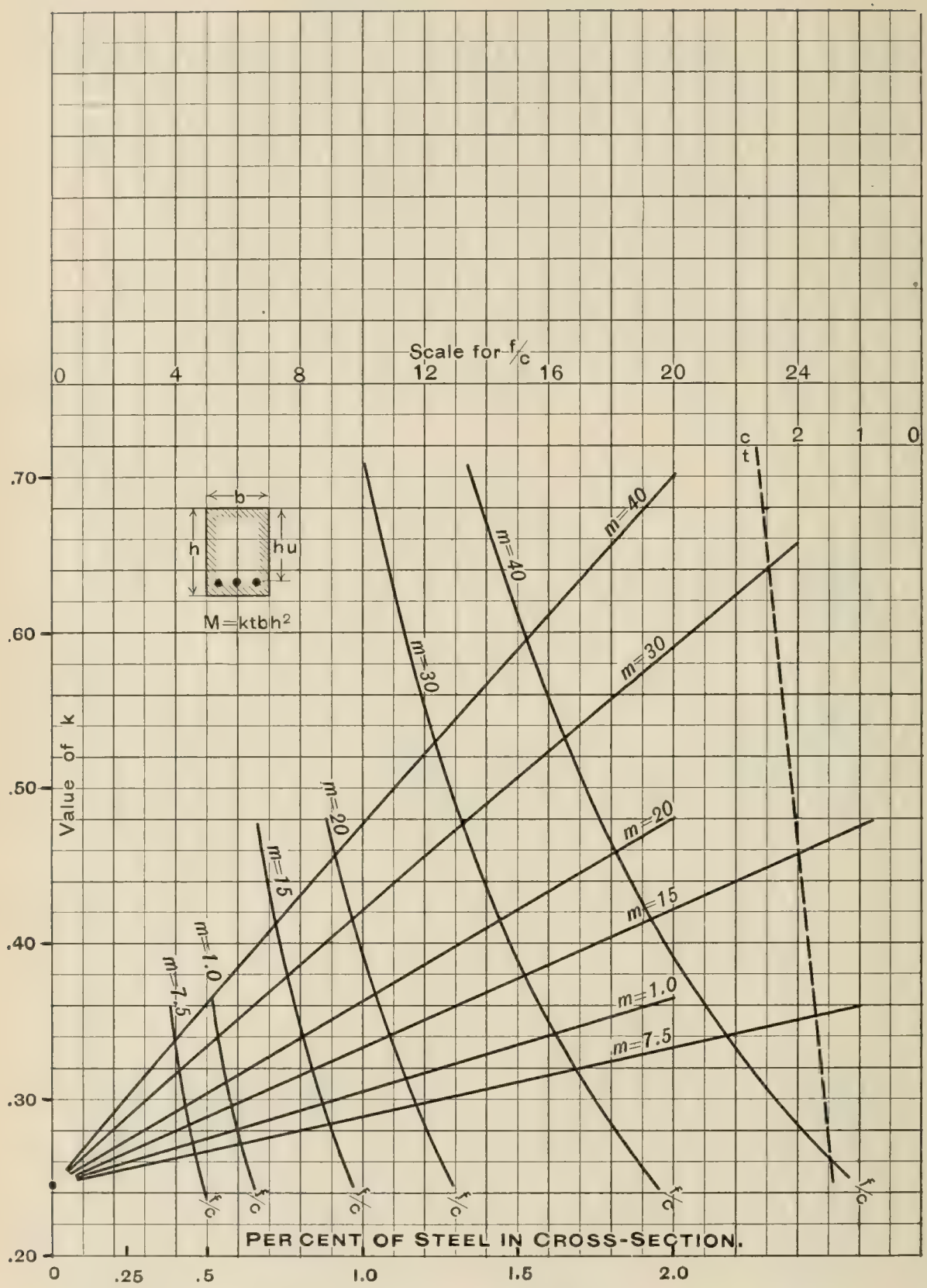


FIG. 3.—DIAGRAM SHOWING VARIATION OF K, WITH PER CENT. OF STEEL IN CROSS-SECTION. $n = 2$, $u = 0.95$ FOR POINT "A."

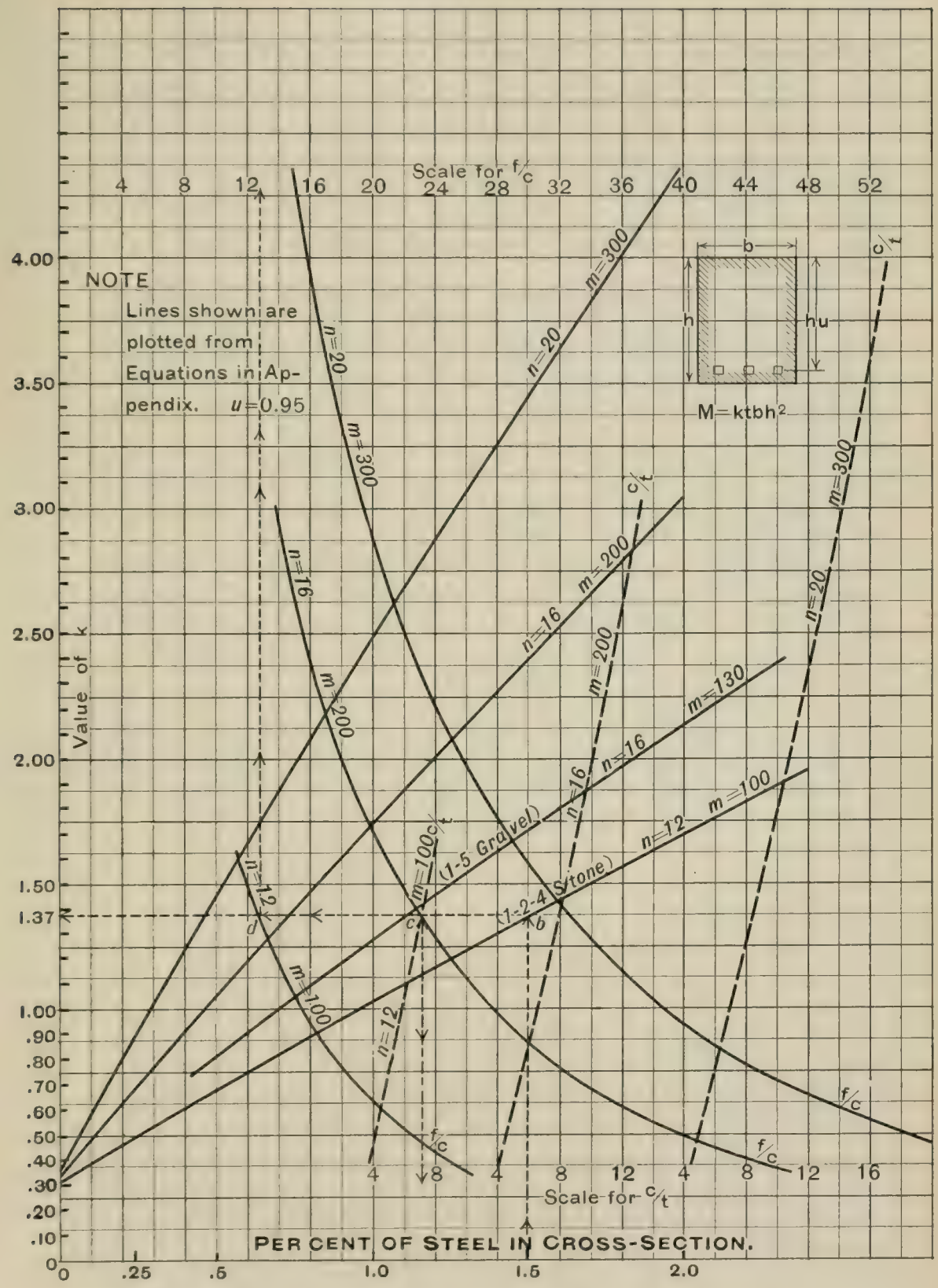


FIG. 4.—DIAGRAM SHOWING VARIATION OF K, WITH PER CENT. OF STEEL FOR POINT OF FIRST CRACK.

of beams made with different percentages of steel placed at different portions of the cross-section both for point A and for the point of first visible crack. The results of the experiments are compared to the theory in Fig. 5 by reference to plotted points, whose values are gotten from Table II. In the future he expects to conduct experiments to cover the upper lines in the diagram. That is to say, to conduct experiments with lean concrete, in which shear will probably be a determinative factor. The comparison of theoretical and experimental results at point A is not satisfactory.

These diagrams suppose failure to be by bending and not by the effects of shear. The same problem comes up in the design of wooden beams. Before designing a wooden beam one must be sure that equations should be applied for bending and not equations for horizontal shear. With these preliminary remarks the nature of the diagrams is explained as follows:

With the use of the diagram required the solution of the following problem:

What depth of beam is necessary to carry 10,000 lbs. center load on a ten-foot span?

Conditions: 1-2-4 concrete one month old. Compressive strength 2,400 lbs. per sq. in. Tensile strength 240 lbs. per sq. in. Reinforcement 1½ per cent. Assume depth of reinforcement from top of the beam equal 0.95h.

$$\text{The required } M = \frac{10{,}000 \times 120}{4} = 300{,}000 \text{ in lbs.}$$

Referring to Fig. 4, run up from the percentage of 1.5 on the horizontal axis to point b on the line marked n = 12, m = 100, thence horizontally to the axis of K to a value of 1.37.

$$\text{Then } \frac{M}{bh^2} = 240 \times 1.37.$$

$$\frac{300{,}000}{bh^2} = 240 \times 1.37$$

$$\text{If } b = \frac{h}{2} h = 12.20.$$

The required beam then will be 6x12.2 in., and will require three 11-16 round bars.

To determine what stress exists in the steel and in the concrete consult Fig. 4. From point b go horizontally to the left to point c on the line expressing the ratio of $\frac{c}{t}$ and thence down to a value of 7.2 on axis of $\frac{c}{t}$.

Since $t = 240$

Therefore $c = 7.2 \times 240 = 1{,}728$ lbs. per sq. in., stress of the concrete in compression.

From the same point b move horizontally to the left to point d on the line which expresses the ratio of $\frac{c}{f}$, thence vertically upward to the scale for $\frac{f}{c}$ to a value marked 13.

Since $c = 1{,}728$, therefore $f = 1{,}728 \times 13 = 22{,}464$ lbs. per sq. in., tensile strength of the steel.

The letters n and m on these diagrams refer to constants in the equations given in the Appendix.

The present evidence from the writer's experiments points to the fact that constants $n = 12$, and $m = 100$, are suitable for 1-2-4 stone-concrete, and $n = 16$, $m = 130$ for 1-5 gravel-concrete.

On Fig. 5 have been represented the results of experiments made by the writer. That is to say, the value of K has been computed from the results of experiments using the value of t as ascertained by parallel experiments conducted on concrete of which the beams were made. It will be observed that the tests on 1-2-4 concrete beams shown by the small crosses fit the constant $n = 12$, $m = 100$, and $t = 300$ lbs. per sq. in., with a satisfactory degree of agreement. It can be noticed that the theory responds to a change of the value of u from ⅞ to ¾ when tested by the results of these experiments. The lines shown in Fig. 4 also run out to an experimental point corresponding to a plain beam without any reinforcement.

The other points of the diagram are for gravel beams which show a greater strength than do the stone concrete beams.

The above remarks refer to the comparisons between the theoretical lines and the experimental points on the diagram showing relations at the time of first crack. The agreement is less satisfactory in the case of point A.

TABLE I.

Kind of Concrete.				Age.	Compression Modulus.	Tension Modulus.	Ultimate Strength.	
Cement.	Sand.	Broken Stone.	Gravel.				Comp	Tens.
1	2	5	.....	90 da.	4,610,000	5,460,000	2413	359
1	2	5	.....	28 da	3,350,000	3.800,000	2290	237
1	.....	.....	5	90 da.	4,800,000	4,510,000	2804	290
1	.....	.....	5	28 da.	4,130,000	4,320,000	2400	253

The writer desires to quote certain results recently obtained in experiments performed in the Laboratory for Testing Materials of Purdue University. Table I gives the modulus of elasticity and strength of both broken stone and gravel concrete at 28 days and 90 days. The limestone was the product of the crusher below one inch. The gravel was excellent pit gravel, including sand and pebbles. The concrete was medium wet. The values quoted are based upon tests of thirty-seven compression specimens, involving two hundred and two determinations of the modulus

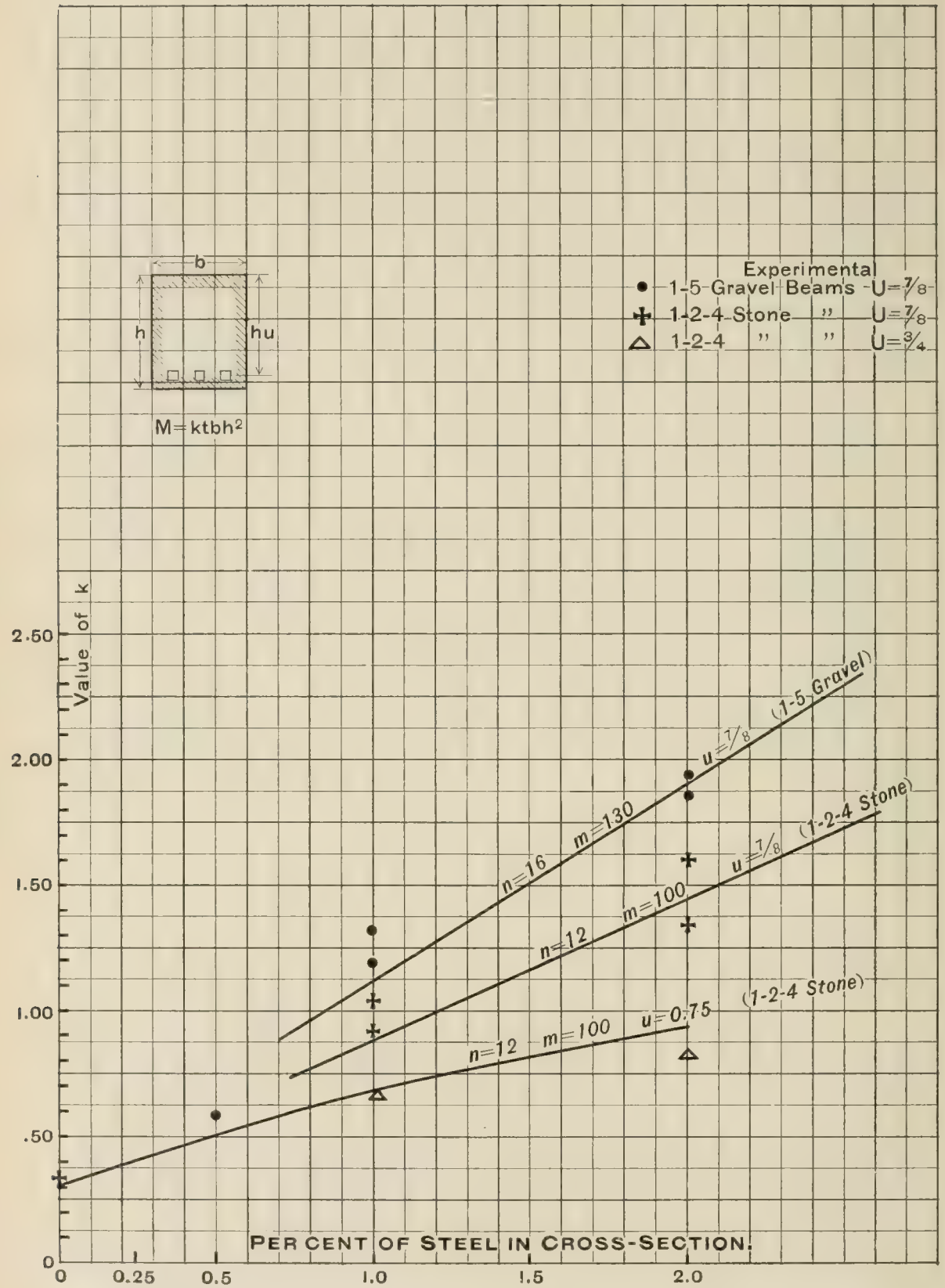


FIG. 5.—DIAGRAM SHOWING COMPARISON OF THEORY WITH EXPERIMENT. LINES REPRESENT EQUATIONS IN APPENDIX.

in compression and on tests of twenty-seven tension specimens, involving seventy-nine determinations of the tension modulus. From these results it appears that the ratio of the modulus of elasticity of concrete in compression to that in tension is nearly unity. The ratio of the modulus of elasticity of the steel in tension to the concrete in compression is as follows:

Stone-Concrete	28 days	8.8
Stone-Concrete	90 days	6.6
Average		7.7
Gravel-Concrete	28 days	8.0
Gravel-Concrete	90 days	6.2
Average		7.1

The value of E is obtained, not from a tangent to the stress-strain diagram, but by subtracting the set preceding the load at which E is measured. This E is very little affected by the stress at which it is measured.

TABLE II.

COMPARISON OF THEORY AND EXPERIMENT.

Concrete beams 8x8 in.—Center Load on 80-in. span. Theoretical value of K computed from equations in Appendix, using values for first crack:

For 1-2-4 Stone $n = 12$; $m = 100$.
For 1-5 Gravel $n = 16$; $m = 130$.

1-2-4 STONE CONCRETE.

u.	Per cent of Steel.	Age Days.	Tensile Strength.	Load in lbs.		Value of K.			
				Point A.	1st Crack	Experiment.		Theory.	
						A.	Crack.	A.	Crack.
7-8	0	28	300	1450	2550	0.189	0.336	.....	0.332
	1	28	300	2750	7050	0.357	0.920	.....	0.920
	2	28	300	3250	10250	0.425	1.340	.....	1.420
3-4	1	28	300	2500	5000	0.326	0.685	.....	0.670
	2	28	...	2500	6100	0.326	0.825	.....	0.950
7-8	1	90	300	....	7815	.....	1.053	.....	0.920
	2	90	300	....	12000	.....	1.553	.....	1.420

GRAVEL 1-5.

7-8	½	90	290	2500	4375	0.336	0.589	.....	0.72
	1	90	290	3000	8500	0.404	1.34	.....	1.12
	2	90	290	3250	13750	0.437	1.85	.....	1.90
7-8	1	28	253	2750	7750	0.425	1.20	.....	1.12
	2	28	...	3000	12550	0.464	1.94	.....	1.90

Note.—The value of n and m used above may be arrived at as follows: *1-2-4 Stone-Concrete:* t = 300 lbs. per sq. in. at point at first crack, elongation is one part in 1000. Es = 30,000,000 Ec = 3,600,000.

$$\text{Then } m = \frac{30{,}000{,}000}{300 \div \frac{1}{1000}} = 100$$

$$n = \frac{3{,}600{,}000}{300 \div \frac{1}{1000}} = 12$$

1-5 Gravel: t = 250. The Gravel Beams had the same deflection at point of first crack as the stone concrete beams.

$$m = \frac{30{,}000{,}000}{250 \div \frac{1}{1000}} = 120$$

$$n = \frac{4{,}130{,}000}{250 \div \frac{1}{1000}} = 16$$

m = 130 was used in Table II to bring closer agreement.

The second series of 1-2-4 beams were tested in 1904, and were of weaker concrete than first series.

APPENDIX I.

THE EQUATIONS OF FLEXURE OF REINFORCED CONCRETE BEAMS.

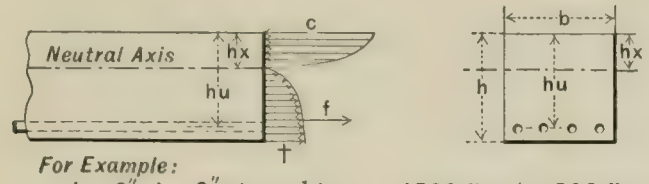
[Mainly taken from paper by W. K. Hatt in Proc. Am. Soc. for Testing Materials, Vol. II, p. 161.]

The theory, the main analysis of which is indicated below, intends to account for the three characteristic points of the load-deflection curve shown in Fig. 5, viz., the point A, the load at first crack, and the load at failure.

The assumptions upon which the theory is based are mainly as follows: (1) The cross-sections of the beam remain plane surfaces; (2) the applied forces are perpendicular to the neutral surface of the beam; (3) the values of the moduli of elasticity obtained in simple tensile and compressive tests will apply to the material when under stress in the beams. (4) There is no slipping between the concrete and the steel reinforcement; and (5) there are no initial stresses in the beam due to shrinkage or contraction of the concrete while setting. The analysis supposes fracture to be due to bending and not to horizontal shear.

If the cross-sections are assumed to remain plane surfaces during flexure, the distortion of any fiber will be proportional to its distance from the neutral axis. It follows that the law of variation of stress will be represented by the stress-strain diagrams shown under simple tests.

Following the method of M. Considère in general by applying these diagrams to the cross-section of a beam, we will have the representation of the stresses at different points of the cross-section. These stresses in the concrete and that in the steel reinforcement are shown in Fig. 6.



For Example:

$h=8''$; $b=8''$; $hx=\frac{1}{3}h$; $c=1500$ lbs.; $\dagger=300$ lbs.; $f=20{,}000$ lbs.; $hu=7''$.

FIG. 6.

For the sake of simplicity in the analysis, these stress-strain diagrams are assumed to be parabolic arcs, an assumption which is justified in the case of compressive stress-strain diagrams by an examination of a large number of tests recorded in "Report of Tests of Metals for the Year 1899." Referring to this figure, let

l = length of span; b = width of cross-section;
hx = the distance from the compression face to the neutral axis;
hu = the distance from the compression face to the center of gravity of the reinforcement;
p = the ratio of the area of steel to that of the cross-section of the beam;
E_s, E_c, E_t = the moduli of elasticity of the steel, concrete in compression and concrete in tension respectively;

$$n = \frac{E_c}{E_t};$$

$$m = \frac{E_s}{E_t};$$

f = stress in metal reinforcement;
c = compressive stress in outer fiber of concrete;
t = tensile strength in outer fiber of concrete.

Reinforcement is supposed to be in the tension flange alone.

E_c and E_t are measured at the stresses c and t.

The values of x, u and p are ratios; p and u are at the control of the designer, while x depends on p, u, n and m; n and m are fixed by the quality of the materials, and they change during flexure with the varying values of c, f and t; that is, the modulus of elasticity of the concrete varies with the stress at which it is measured. For practical purposes of computation, however, the constant values of n and m may be used appropriate to the point A and to the point of cracking shown in Fig. 1.

On the assumption of plane cross-sections during flexure, we may determine the ratio of c to t and f to t as follows:

$$c = \frac{t\,n\,x}{1-x}. \qquad (1)$$

$$f = \frac{t\,m\,(u-x)}{1-x}. \qquad (2)$$

The values of c/t and f/c are shown in Figs. 3 and 4.

Next, to locate the neutral axis; that is, to determine the value of x, we may equate the forces of tension and compression on the cross-section, assuming, as before, that the stress-strain diagrams are arcs of parabolas. Thus:

$$\tfrac{2}{3}\,c\,x = \tfrac{2}{3}\,t\,(1-x) + p\,f. \qquad (3)$$

Inserting the values of c and f obtained above, we obtain the following quadratic:

$$\tfrac{2}{3}\,x^2\,n = \tfrac{2}{3}\,(1-x)^2 + p\,m\,(u-x).$$

Solving the quadratic we have:

$$x = \frac{-\left(\frac{4+3\,p\,m}{2}\right) + \sqrt{4\,n + \frac{9}{4}\,p^2\,m^2 + p\,[6\,m\,(u\,[n-1]+1)]}}{2\,(n-1)} \qquad (4)$$

Having obtained x, we may compute c and f, and finally obtain the moment of resistance of the section. Taking moments about the neutral axis, we have: M =

$$t\,b\,h^2\left(\frac{5}{12}\,(1-x)^2 + \frac{5\,n\,x^3}{12\,(1-x)} + p\,\frac{(u-x)^2}{1-x}\,m\right): \qquad (5)$$

It is the bracketed expression which is shown as K in Figs. 3 and 4, in which p is, however, a per cent. and not a ratio, as in Eq. (5).

No useful development will result from the substitution in Eq. (5) of the value of x, obtained in general terms in Eq. (4). In practical computations, n,* m, u and p are given; x is then computed from (4); c and f computed from (1) and (2); finally the moment of resistance is computed from (5).

The process of computation is simplified by the fact that the values of m and x are the same for equal products of p k.

The equations given above are to be applied to compute the load at the point A. At the load corresponding to the cracking of the concrete in the tension face, these equations should be modified to correspond with the fact that the stress-strain diagram for the concrete in tension is more nearly a rectangle than a parabola. The difference, however, between the results at the time of the appearance of the crack due to the assumption of

*If $n = 1$, then $x = \frac{2+3\,p\,m\,u}{4+3\,p\,m}$

FIG. 7.—SHOWING NATURE OF FAILURE OF 1-2-4 STONE CONCRETE BEAMS.

a rectangle or a parabola is small. With proper values of n and m the equations may be allowed to stand.

Apparently the following values of n and m may be used to compute the load at first crack:

For 1-2-4 stone concrete, $n = 12$; $m = 100$.
For 1-5 gravel concrete, $n = 16$; $m = 130$.

When, however, the crack having formed itself, extends throughout the lower region of the cross-section, the equations must be modified by the omission of the effect of the tensile forces due to the resistance of the concrete under tension.

We have then:

$$\tfrac{2}{3} c x = p f \text{ or, } p \frac{E_s}{E_c} (u - x) = \tfrac{2}{3} x^2, \quad \ldots\ldots\ldots\ldots \quad (4)^1$$

which serves to locate the neutral axis. When f is assumed to be the elastic limit of the reinforcing metal c may be computed. As noted above, in the stone-concrete beams tested by the writer, the elastic limit of the iron was reached before the concrete failed in compression.

The resisting moment of the section is then

$$M = b h^2 \left\{ \frac{5}{12} c x^2 + p f (u - x) \right\} \ldots\ldots\ldots\ldots\ldots\ldots (5)^1$$

DISCUSSION.

Mr. J. P. Snow (Boston & Maine—by letter) :—The three excellent reports submitted by the Committee on Masonry in Vols. 2, 3 and 4 of the Proceedings show a large amount of study and investigation, and the Association should feel grateful to the Committee for their work. The modification in the classification of masonry proposed in Circular No. 41 appears to me to be a great improvement on previous reports. I am not sure but it would be an improvement to drop the word "ashlar" and use the word "range" alone. Ashlar should be used for the walls of buildings, where the joints are cut to ¼ in. or less, rather than for bridge abutments and retaining walls, where the joints are generally much wider.

The word "coursed" is used in New England instead of "range," but the latter is shorter and serves to differentiate cut-work, where the course is made up of one stone in height, from rubble courses where several stones may be used in places to make up the layer.

I beg to suggest that it might be better to use the word "wall" instead of "other" as the term defining brick masonry that is laid in horizontal courses in the usual manner.

Under definitions I would omit "ashlar," as its definition is covered by "dimension stone."

"Coping" does not always overhang the wall; the definition should be modified to recognize this, or a new term, "capping," be used to cover the case.

I think the Committee should give us terms for the top, bottom and end surfaces of stones in a wall. The terms "bed" and "joint" are badly overloaded in our trade vernacular. I am glad to see that a single meaning is assigned to each in the Committee's lexicon. It is perhaps good grammar to use a given word as noun, verb, adjective and participle with proper endings, but it is not good composition to give it several different meanings in each of its phases. If the English language does not furnish words enough to provide a single term for each kind of joint, we should use two or more to secure precision of meaning.

I would suggest that the word "pinner" have a place in the list as a spall or small stone used to fill joints, or to wedge up a stone which might otherwise tend to roll on its bearings. We often specify that rubble work shall have no pinners in the face.

Levellers, jumpers or dutchman should also have a place, as small rectangular stone used in broken range work to make a thin stone justify with a thick one so that the stone above may make a proper bond and have a continuous bed. It is legitimate in specifying for this class of work to prescribe a minimum thickness for these stones of, say, 4 in.

Regarding concrete: Could the Committee give us approved methods of treating the face of exposed concrete masonry where appearance is a factor? We see in the specifications that the face shall be rubbed after the forms are removed. What tool is used for this, and is the pneumatic hammer a good instrument for pointing the face so as to relieve the bald appearance of plain concrete and remove the print of the forms and equalize the color?

I do not feel competent to properly discuss a specification for Portland cement concrete, but I favor a consistency fully as wet as the Committee prescribe. I think it should be soft enough so workmen would sink into it nearly ankle deep. Packing such concrete can hardly be called tamping; it should be jarred or "joggled" (as William B. Fuller calls it) to its place.

Mr. Hunter McDonald (Nashville, Chattanooga & St. Louis—by letter):—The necessity for excluding the dust from crushed stone is not apparent. A reasonable amount of dust, excluding that which would be fanned out by a mild blast, is beneficial, since it is equivalent to and as good as so much sand. The ideal concrete material is crusher-run stone, with crusher set to crush one and three-quarter-inch stone, large flats only being screened out. Six units of such material with two units of sand and of packed cement gives excellent results.

Some original investigations by the Committee as to the most economical size for crushing stone and the drawing of specifications resulting therefrom would be most acceptable.

It is impossible to finish the top surfaces of sloping wing walls, as the work is brought up in horizontal layers. The specifications should describe how these slopes should be left when first put up and how treated for the final finish, in order to secure best union between the old concrete and the new finishing mortar. Provision should be made for beveling square corners and throating coping.

Clause 3 under the word "course" provides for work to be brought up in sections. This should not be done, except in the case of an expansion joint. Courses should be made to break joint not less than two feet. The necessity for expansion joints is a subject which invites further investigation.

Mr. F. G. Jonah (St. Louis, Brownsville & Mexico—by letter):—The writer begs to offer the following suggestion as to the specifications for Portland Cement Concrete: The specification for consistency is not definite, as it states that "the concrete shall be of such consistency that when dumped in place it will not require much tamping." It might be made so thin that it would not require any. I believe this should read: "Concrete shall be of such consistency that when dumped in place the mortar will not run or separate readily from the stone and so that when well rammed the water will just flush to the surface."

I think the thickness of courses should be provided for and believe that concrete should be placed in layers not to exceed 9 in. in thickness.

Facing: I believe a shovel facing, that is, a careful working

of a smooth shovel or spade against the forms, will give a more satisfactory job than plastering the forms with a facing of mortar.

FINISHING: In this clause the composition of the mortar used in filling small cavities should be specified. It should be the same proportion as that used in the concrete. Frequently a neat cement, or one part cement and one part sand mortar, is used for the purpose, and it takes a different color to the body of the structure when set, thereby becoming conspicuous and spoiling the appearance of the work. Would suggest inserting, after the word "mortar," "of the same proportions as used in the concrete."

MR. C. S. CHURCHILL (Norfolk & Western—by letter):—I think that the definitions and specifications are well drawn up. I would suggest that under the head of "expansion joints" the maximum length of concrete wall be specified in which no expansion joint is required; for example, a long arch. Our rule is to make the maximum length of an arch or retaining wall without expansion joint 50 ft. In other words, if the length of the arch or retaining wall was 95 ft., we would place the expansion joint at the center.

We have not had time to give the specification for concrete as much study as we hope to give it, but in general we wish to say that, in our opinion, the specification is excellent and should be commended for its clearness and brevity.

MR. WM. ASHTON (Oregon Short Line—by letter):—The following suggestions occur in reference to Circular No. 41, Specifications for Portland Cement Concrete:

Mixing by hand, section 1: "Tight platforms shall be provided of sufficient size to accommodate men and materials for the progressive and rapid mixing of at least two batches of concrete at the same time. Batches shall not exceed one cubic yard each, and smaller batches are preferable, based upon a multiple of the number of sacks to the barrel." As I understand it, this proposed specification is for general use; small jobs as well as large jobs. If this is the case, why specify that sufficient space be provided for the mixing of at least two batches of concrete at the same time, when possibly only one batch is required, or possibly only force required for the mixing of one batch, even though two batches might at times be utilized on the work. Assuming that the work to be performed is of sufficient size to call for enough concrete for the two-batch system, the proposed specification is, of course, entirely proper and the suggestion a good one. It would seem to me, however, that for a general specification that portion of this section "of at least two batches of concrete at the same time" might as well be left out, or put in with the proviso that "when sufficient amount of concrete is required to warrant."

Under the heading "course," section 1, there seems to be no mention made as to the thickness of courses to be laid. It has been my experience that in placing concrete in courses of too great thickness the voids are not as liable to be thoroughly filled or the mass worked to form voids

as well as where the courses are put in of moderate thickness. I should say 8 to 12 in. in thickness, dependent upon the work. In our abutment work we frequently put in courses of greater thickness, and skilled men, who thoroughly understand the object to be attained, obtain good results in courses of 15 or 16 in.; yet I would not care to recommend courses of such thickness in a general specification.

Placing of concrete in freezing weather: It might not be out of place in a general specification to give some approved method of procedure for placing concrete in severe cold weather. Many railroads, as well as contractors, are obliged to put in concrete during the coldest weather. Some heat the water; some heat the sand; some heat both; some use salt; some cover and protect the concrete to a greater or less extent, to the end that it may attain at least its initial set before it freezes. Some engineers try to secure a brand of quick-setting cement for use in cold weather.

Finishing, section 1: Is it the intention to recommend the whitewashing of concrete in general? It has been my experience that, beyond the filling up of the small cavities, concrete built to well placed forms of surfaced lumber presents fully as good an appearance without the whitewash, and, unless the whitewash is properly applied, in a very small quantity, it is liable a little later to scale and injure, rather than improve, the appearance of the work.

Concrete under water: While most of us are familiar with the ordinary method of placing concrete under water, undoubtedly some of the members of the Association have acquired, by experience, knowledge that would be of value, which could properly be incorporated in a general specification.

Mr. D. MacPherson (Canadian Pacific—by letter):—In specification for concrete stone, the Committee adhere to the usual size of stones, not exceeding two inches in any direction. It has never been clear to me why this size has been so universally considered necessary, or why it should make better concrete than stones of three inches or four inches in size. It is by no means an established fact that we can make concrete harder or stronger than granite. Why, therefore, should we break 4-inch cubes into eight pieces for the purpose of cementing them together again into a less strong and less durable mass? The larger stones would, of course, have larger voids in the dry mass, but with careful mixing and placing, all voids can be filled, and stronger work done with large than with small stones.

It appears to me that riprap and paving should be classed as dry masonry, and the proposed definition for masonry seems to conflict with that for riprap, masonry being defined partially as: "All constructions of stone, or kindred substitute materials, in which the separate pieces are placed together," and rip rap as: "Rough stones of various sizes placed compactly or irregularly."

The word "Build" does not appear a very happy definition of a vertical joint, and it would be interesting to know the reasons for its adoption.

MR. W. C. CUSHING (Pennsylvania Lines—by letter) :—In the report of the Chief of Engineers, United States Army, for 1902 there is an interesting letter from Captain Harry Taylor, Engineer Corps, United States Army, on tensile strength of briquettes made from crusher dust, compared with those made from commercial sand or standard crushed quartz, and the information gained by these tests indicates that the concrete made by the use of crusher dust instead of sand has a considerably superior strength over concrete made with commercial sand or standard crushed quartz. Some tests have also been made by the Chicago, Milwaukee & St. Paul Railway which corroborate the value of the results mentioned above. I think, therefore, that the paragraph headed "Sand" should be followed by a specification for crushed limestone sand.

The word "uncompleted" is incorrectly used under the heading "Course." I think it would be better to make No. 3 under "Course" on the same page read: "The work should be carried up in sections of convenient length and the *sections* completed without intermission."

On page 4, under section 3, it will be well to consider the use of a mixture of alum and lye for the thin coat to be applied on the tops of arches to make them as nearly waterproof as possible. This mixture is also recommended in the same report of the Chief of Engineers, United States Army, from which extracts are quoted in Engineering News, April 2, 1903. The proportions recommended are, one pound of concentrated lye and five pounds of alum to two gallons of water, constituting the stock, which may be mixed in any quantity. To one pint of the stock add ten pounds of cement, thinning out with water until the mixture spreads easily and well on the walls with a calcimine brush, filling all the pores in the plaster. The Captain who made this report states that the preparation has been found to be strictly waterproof and that no more than two coats are necessary. In addition to its waterproofing properties it prevents fungous growth on or discoloration of surface coated with it.

Regarding the definitions of masonry terms applied to railroad construction, this is a very important subject, as it is the foundation and basis for making a classification of masonry. A uniform and distinct understanding concerning the different classes of masonry is very essential, and the Association will be accomplishing a good work if it puts this subject before its members in such a way that there will be a clear understanding of the different terms used in masonry work, and especially the distinction between the different classes employed. I am, therefore, pleased to note that the Committee has broken away from its original recommendation of first, second, third and fourth classes, which mean nothing, and are now recommending a classification which is more logical and which will be more readily understood when clearly stated. However, I do not think the Committee, in Circular No. 41, has yet handled the matter as fully or clearly as should be done. The necessity for this work was recognized by the American Society of Civil Engineers many years ago, and in Vol. 6 of their Transactions an attempt

was made to put this matter on a proper basis. Apparently, however, much attention has not been paid to that report by the fraternity as should have been the case. This good work was carried on by Professor Ira O. Baker, and he plainly states in a treatise on masonry construction, in 1889, that he has used in his book the information gathered together by the American Society of Civil Engineers. It has always seemed to the writer that the information in Professor Baker's book is a good starting point, and the Pennsylvania Lines West of Pittsburg long ago abandoned the use of the terms first, second, third and fourth class in masonry construction. It is, therefore, suggested that the Committee will find very much meat in Professor Baker's book, both in masonry classification and for definition of masonry terms. What the writer recommends in this communication has been freely taken from Professor Baker's book, and the classification of masonry table submitted herewith is made up from that information, but placed in a way which should make the subject more easily understood.

The solidity, character and appearance of masonry are dependent upon four things, viz.:

(1) Classes of the material as defined by such terms as dimension, arch, ashlar, squared stone, rubble, etc.

(2) The manner of work, or way in which these pieces of material are placed in the structure.

(3) Dressing, or the degree of finish given to the beds and joints, or builds.

(4) The surface finish or face of the individual pieces of material.

Various combinations of these four different things will result in different classes of masonry structures, and as different structures require different degrees of perfection, it seems to the writer that for our railroad purposes it is better to talk about "Bridge Masonry," "Arch Masonry," "Box Culvert Masonry" and "Retaining Wall Masonry," rather than to speak of "First Class," "Second Class," "Third Class Masonry," etc. The specification for bridge masonry of the Pennsylvania Lines West of Pittsburg takes in all ordinary bridge abutments for spans up to 150 feet in length. When an important bridge of long span across a wide river is to be built, a special specification is written which will give a higher quality of structure and is in general a combination of dimension stone and ashlar masonry in its highest signification.

As to the definitions themselves, I submit the following criticisms, the definition in each case being as recommended by the writer:

ASHLAR.—A squared or cut block of stone of rectangular dimensions.

ASHLAR MASONRY.—A collection of ashlar blocks built up in a masonry structure with parallel and continuous beds. The beds and joints, or builds, are usually less than ½ inch thick, and headers and stretchers alternate. Backing is of such size that very few spalls are necessary for filling.

Kinds of Masonry.	Sub-division into Classes of Material.	Manner of Work.	Dressing.	Face or Surface Finish.
Stone	Dimension	In courses	Fine-pointed Crandalled Axed or Pean-hammered Tooth-axed Sawed Rubbed	Quarry-face Pitch-faced Drafted
	Arch	In courses	Fine-pointed Crandalled Axed or Pean-hammered Tooth-axed Sawed	
	Ashlar	Range Broken Range		
	Squared Stone	Range Broken Range Random	Rough-pointed Fine-pointed Crandalled	
	Rubble	Coursed Uncoursed	None	Quarry-faced
	Dry	No mortar	May be any of the above	May be any of the above
Concrete	Broken Stone Gravel Cinder or other Material			
Brick		English Bond Flemish " Hoop-iron"		Pressed Rough

BACKING.—That portion of a masonry wall or structure built in the rear of the face. It must be attached to the face and bonded with it. It is usually of a cheaper grade of masonry than the face.

BATTER.—The slope or inclination of the face from a vertical line.

BEDS.—The horizontal joint in masonry structures.

BOND.—The mechanical disposition of stone, brick or other building blocks, by overlapping to break joints or builds.

BROKEN RANGE MASONRY.—Or Broken Range Work. Masonry in which the beds are parallel but not continuous.

CONCRETE.—A compact mass of broken stone, gravel or cinders, assembled together and allowed to set.

COPING.—A top course of stone or concrete slightly projecting beyond the wall to shelter the masonry from the weather and distribute the pressure from exterior loading.

DRESSING.—The finish given to the surface of stones, or to concrete.

DRY WALL.—A masonry wall in which stones are built up without the use of mortar.

FORMS.—Framed structures for holding concrete in desired shape until the final set is attained.

LAGGING.—Horizontal strips used to carry and distribute the weight of arch voussoirs to the ribs or centering during their setting.

RANGE MASONRY—Or Range Work. Masonry in which the various courses are laid up with continuous horizontal beds.

MORTAR.—A mixture of sand, cement or lime, and water used to cement together the various stones or brick in masonry work.

RUBBLE MASONRY.—Masonry composed of squared or roughly squared stones, or rubble of irregular size or shape. It may be coursed or uncoursed.

There are many omissions from the definitions, as the Committee is no doubt aware, but it seems to me that many have been omitted which are fundamental in the understanding of masonry work. Professor Baker's book, above quoted, is recommended for giving valuable information in this respect. For instance, it seems to the writer that the different kinds of tools should be defined and illustrated. Then the dressing of stones should be clearly explained, and but very few of the terms used in arch masonry have been given. As explanatory, the writer suggests the following as a few of those which should be added:

SQUARED-STONE MASONRY.—Work in which the stones are roughly squared and roughly dressed on beds and joints, or builds. The beds and joints, or builds, are usually more than ½ inch thick, and headers and stretchers are laid in the proportion of about one header to three stretchers.

PITCHED-FACED STONES.—Those on which the arris is clearly defined by a line beyond which the rock is cut away by the pitching chisel, so as to make approximately true edges.

ARRIS.—The edge formed by two surfaces, whether plain or curved, meeting each other.

DRAFTED STONES.—Those on which the face is surrounded by a chiseled draft, the space inside the draft being left rough.

ROUGH-POINTED.—Dressed by pick or heavy point until the projections vary from ½ inch to one inch.

FINE-POINTED.—Dressed by fine point to a smoother finish than by rough point.

CRANDALLED.—A speedy method of pointing, the effect being the same as fine-pointed.

AXED—Or Pean-hammered and Patent-hammered. Axing covers the surface with chisel marks, which are made parallel as far as practicable. The patent-hammer has a number of chisels held together and makes a smoother finish.

TOOTH-AXED.—A speedy method of fine pointing.

BUSH-HAMMERED.—A surface produced by pounding the roughnesses of stone with a bush-hammer. This kind of finish is dangerous on sandstone.

RUBBED.—A fine finish made by rubbing with grit or sandstone.

In defining arch masonry "extrados" and "intrados" are used but are not defined, and there are many other terms used in arch masonry work which are well defined in Professor Baker's book and which we should assist in making known.

MR. CHAS. M. MILLS (Principal Assistant Engineer, Philadelphia Subway & Elevated R. R.—by letter):—I give below my views regarding a few points referred to in the Circular No. 41 of the Masonry Committee:

SAND: I find considerable difficulty sometimes in getting sand of

the proper quality, and think that "free from all loam, dirt or dust" is hardly sufficient. It is practically impossible in this neighborhood to get sand which is free from loam. I would recommend that consideration be given to a limitation for loam, and that some quick method of determination, such as the use of a standard turbidity tube, be used.

GRAVEL, for Concrete: The same comment as to the limitation on loam will apply here. Owing to the conditions applying in this market, and owing also to long established usage, our specification for concrete requires crushed stone, used with what would be considered fine gravel, the latter being graded from coarse to fine, so that a considerable percentage of it can be properly called sand.

CONSISTENCY: Our practice is to make concrete which would be considered very wet, except in special cases. I am convinced from my personal experience that this gives the most dense and compact concrete. A larger amount of the concrete ingredients can be placed in a given space when the concrete is of this consistency than when it is dry, with the obvious conclusion. I think that the clause in Circular No. 41 on "Consistency" is very good. I have found that in placing concrete it is essential to have intelligent and trained inspectors, and have preferred to have the consistency determined by special instructions to the inspector, as the circumstances require.

COURSE: I think the clause under this title is very good. In reinforced concrete work and in building retaining walls, it is my practice to have a piece of scantling placed at the end of all vertical joints, to make a rabbeted joint as the adjoining section of the wall is placed. I do this also in horizontal joints, as a rule. In mass work, I allow the placing of stones in the work. When this is done, there is no difficulty in getting a good lock between courses. I would recommend that the word "dampened" on page 3 of the circular be changed to "wet."

EXPANSION JOINTS: I have found that the expansion joint question is a detail for which it is hard to prescribe a general rule. In some cases I have found it desirable to provide for considerable movement in walls by the use of bars of steel, so placed in the forms as to make a sliding latch, so that the alinement of the wall would be maintained in case of a tendency of one section to move out under pressure past the adjoining section. In some cases I have made a joint by finishing up against the end forms, so that the concrete in the succeeding section would be deposited against the hardened face of the section previously completed. This, as I understand, is what you intended by the clause on "Expansion Joints."

Referring to the matter of definitions, I have given a cursory glance and have not the time to give a more thorough examination of them. I notice what appears to be a little ambiguity in the use of the word "bed," and a definition is given on page 5, yet this word is used in an entirely different sense on page 6 in the definition of "foundation."

Referring to crushed stone for concrete, in which a graded stone, maximum size 1 in., is called for in our specifications, I would state that this size was fixed, as a large part of the concrete work done in our subway construction is reinforced with steel rods. Where concrete is

used in mass, such as abutments or retaining walls, without steel reinforcement, the maximum size of the graded stone is 2 in.

In our specifications for "General Construction," which cover all kinds of work for substructures and superstructures, as required for our subway and elevated railroad construction, I placed the upper limit for the graded stone at 1 in. to avoid the difficulty due to having two grades of stone, which might cause confusion on the work. My reason for doing this is that a large part of the concrete work done in our subway construction is reinforced with steel rods, making it desirable to keep the maximum size of stone down to 1 in. I found that in this market there was not sufficient difference in price between the stone with 1 and 2 in., respectively, as the upper limits, to make it an object to incur liability of confusion by having the two sizes delivered on the work.

Referring to the maximum size of the crushed stone for reinforced concrete work, I would state that I think very well of making this ¾ in. instead of 1 in. I notice that the Rules of the Building Inspection Bureau of New York City, as published in the Engineering News recently, have fixed this as the maximum size for stone allowed in reinforced concrete work.

While I have a specification for cinder concrete, I have found, and expect to find, very few places where this class of material will be of any use to me.

Referring to slag concrete, in this market slag costs as much as stone, and as it is so porous, I prefer to use a good quality of stone.

Mr. R. W. Lesley, Philadelphia, Pa. (by invitation of the Committee) :—Portland Cement: My first and permanent thought is that no matter how good the specification is that any of the engineering or scientific bodies can produce, it will not have the same value and carry the same weight among consumers, engineers and producers as a uniform specification representing the thought of all and a common standing-ground. For this reason, and in view of the fact that I was the temporary chairman of the Cement Committee of the American Society for Testing Materials, and also, as president of the Association of Portland Cement Manufacturers, appointed the Committee on Cement Specifications of that body, and, further, as an Associate of the American Society of Civil Engineers, have added my small quota to the preparation of the Progress Report of the special committee on Uniform Tests for Cement of that body, I feel that it would not be proper, in view of the fact that all three of these bodies have agreed upon the Manipulation of Tests of Cement, recommended in the progress report of the American Society of Civil Engineers, and have had some forty laboratories at work making tests under these methods of manipulation, to in any way criticise or suggest anything in the methods of manipulation of testing cement, other than those suggested in the very able and intelligent report made by the Cement Committee of the American Society of Civil Engineers, which I sincerely hope your body will adopt, as governing all that which relates to testing and methods of manipulation of the same.

As to Packages, Weight, Condition, Rejection, Sampling, Fineness—

all these subjects are fully covered in the progress report of the American Society of Civil Engineers, already referred to, and which, as above stated, I trust, will be adopted as a whole by your body.

On the question of the Soundness Test, on page 2, I can not too strongly urge the adoption of the report of the American Society of Civil Engineers, to be found on page 13 of their paper, under the head of "Constancy of Volume."

The difficulty of a proper boiling test is so great and its indications are so doubtful that, with an experience of over thirty years in the cement business, I can not in any way agree with it or with its results. This has been demonstrated in Europe, and will certainly be demonstrated fully in this country.

The qualification of the Committee that this may or may not be a cause for rejection, at the option of the engineer in charge, is to be highly approved. The difficulty is, that in the clause of the Committee covering this test it is more than likely that a slow-setting cement may go into the water which will rise to the boiling point before the cement has actually set, and if such a test is to be adopted by your body, I would strongly recommend that the boiling tests suggested by the Rapid Transit Commission in New York be followed, which allows the pats to remain at least 24 hours in air or water before proceeding with the boiling operation.

By a reference to my discussion of Mr. Taylor's paper, read at the meeting of the American Society for Testing Materials, at Delaware Water Gap, Pa., July 1, 2 and 3, 1903, it will be noted I make the suggestion that the time of boiling should be at the expiration of either the 7 day or 28 day periods, when any possible question of the seasoning of the cement will be definitely settled.

The percentage of water, referred to in paragraph 6, has considerable to do with the question of boiling because if too little water is used in making the briquette, a disintegration may be set up by the opposing action of the boiling water.

The suggestion that the pat should be left at least 24 hours in moist air before being exposed to boiling is certainly a reasonable one, when considered in connection with the fact that the Committee allows a cement to have "at least a period of 10 hours for final set, and that briquettes for the simple 24 hour test are to be allowed to set at least 24 hours in moist air." Certainly the boiling test is a more aggressive one than the 24 hour test, and the briquettes should be afforded at least that length of time before being exposed to the violent physical and destructive action of boiling water.

On the question of paragraph 6, page 3, relating to the specification, the figures are entirely reasonable and proper and should procure first-class cement. Such a cement as this, made up with the proper percentage of water, say 22 per cent. or 23 per cent., will give a gain of 10 per cent. above the tests of the 7 day period, on the 28 day results. There is much to be said on this increase in strength between the 7 day and 28 day periods, and recent examinations by me of a series of tests covering the Aqueduct System in New York, the Rapid Transit System in New

York, the Boston Aqueduct System, the Philadelphia Filtration System and Municipal work, the District of Columbia tests, and records from several other important works, show that with the average revolving kiln cement, figures considerably in excess of 500 lbs. are obtainable at 7 days, but these cements rarely show the 10 per cent. gain at the 28 day period.

Experiments made at our works show that even these high-pulling cements at 7 days will give the gain if a proper percentage of water is used, or, in other words, that with a minimum of water the gain will not be obtained, but with a fair percentage of water gain will be obtained, thus indicating that the 10 per cent. increase in strength is largely a question of the percentage of water used and not actually the percentage of gain in the strength of the cement.

The Committee's specification is fortunately free of this question of the percentage of water, though it includes that "this percentage will be found to be approximately 20 per cent. of the weight of the cement." I feel certain, from my knowledge on this subject, that so small a percentage of water will not give the increase in strength between the 7 day and 28 day periods.

As to Specific Gravity and Chemical Analysis, these questions are covered in the progress report of the American Society of Civil Engineers, already referred to, which I respectfully recommend.

On the ground of uniformity, the Committee's clause is an extremely wise and sensible one. The manufacturer as well as the consumer is interested in the production of a uniform cement, and no manufacturer desires to produce anything but that grade of material. Co-operation between the engineer and manufacturer on this subject is greatly to be desired.

I would suggest the definition of natural cement be defined as a product formed by the calcination at low temperatures of argillaceous limestone, which, after pulverization and being made into pats, does not disintegrate in water. This criticism is made because a perfectly good natural cement can be produced without the argillaceous limestone containing magnesia in any of its forms, whereas, in the definition of the Committee, carbonate of magnesia would be an essential element, a fact contrary to the chemical analysis of many of the best natural cements in the country.

So far as Packages, Weights, Condition, Storage, Rejection, Sampling, Fineness and Set, all of these subjects are covered in the progress report of the American Society of Civil Engineers, cited above.

The tests of tensile strength are certainly reasonable, and good cements should show the figures mentioned. The ratio of gain between the 7 day and 28 day periods should be obtained, except, possibly, in some cases of natural cement made from Portland cement rocks slightly below the Portland cement analysis in lime, and burned fairly hard.

Improved Cements: The suggestion also comes to my mind that there is no provision made for a large class of cements which in the East are found to answer many purposes and to give most excellent results.

These cements are admixtures of natural cement and Portland cement clinker, and are made at a number of mills in the Lehigh region in Pennsylvania, and have been practically standard on such roads as the Pennsylvania Railroad, Lehigh Valley, Baltimore & Ohio and Philadelphia & Reading railroads, and also on the large work of paving, sewerage, etc., in the city of Philadelphia.

All that applies to natural cement should be properly applied to this grade of cement, with the condition that the tensile strain should be

Age.		Strength.
7 days	1 day in air, 6 days in water; NEAT	200 lbs.
28 "	1 " " 27 " " "	300 "
7 "	1 " " 6 " " 1 part cement, 2 parts standard quartz sand	120 "
28 "	1 " " 27 " " "	200 "

which figures are from the specification of the city of Philadelphia for this grade of cement.

Mr. R. M. Pearce (Pittsburg & Lake Erie—by letter):—I would offer one or two suggestions in regard to the specifications for cement concrete:

The portion of Pittsburg & Lake Erie specifications which refers to the manner of putting in concrete in turning arches is sufficiently important to be embodied in these specifications. They are as follows:

Arch rings of arch culverts and for parapet head walls and copings to same, concrete, in proportions of one, three and five, shall generally be used. Concrete of these proportions shall also generally be used for parapet walls behind bridge seats of piers or abutments, and for the finished copings (if used) on wing walls of concrete abutments.

The centering for arch barrels must be well built and unyielding and must conform to lines given.

Forms and centers in arches shall remain in position for at least thirty days after completion of arch, and under high fills as much longer as the engineer in charge may direct. Concrete in arch barrels shall be placed with the utmost care. The work in general will be done by placing the concrete in layers on the spring lines, about 6 in. thick at the intrados and extending back to and including the haunch filling; the upper surface of each layer to be in a radial plane from center of the arch; this process to be continued until the upper surfaces on each side make angles of from 30 to 45 deg. with the horizontal, as may be determined by the engineer in charge. Then so much of the remaining closure or key shall be divided off by a vertical mould or partition at right angles with the center line of the arch that can, in the opinion of the engineer in charge, be built as a continuous operation. The concrete in this closure or key shall be put in place in annular layers, concentric with the arch center and from 6 to 8 in. thick. The sizes of the batches mixed must be so arranged that one complete layer will be completed by each batch.

The vertical moulds so placed at the end of a section of the key must be allowed to remain in place until that section is, in the opinion of the engineer, firmly set. This mould may then be removed and another section commenced.

Arches must remain uncovered by fills at least one week after completion, and in special cases as much longer as the engineer may deem necessary; during construction and also during this period after completion, the concrete work must be protected with loose plank against storms, etc.

In connecting new concrete with work already set, the old surface shall be cleaned and thoroughly wetted.

The President:—I wish to state for the information of the convention that the specifications for Portland cement are now being considered by a committee of the American Society for Testing Materials, and they have asked for representatives of the American Society of Civil Engineers, the American Association of Cement Manufacturers and of this Association, to meet that committee. In compliance with that request the Board of Direction has appointed Mr. H. G. Kelley, Prof. G. F. Swain and Mr. C. W. Boynton to represent this Association. Mr. Boynton and Prof. Swain are already on the joint committee as representing other associations. Our instructions to our delegation are that they participate in the proceedings and report their action back to this convention for approval. The discussion and adoption of the proposed specifications, it seems to me, would therefore be unnecessary in view of that action. I think the Committee agrees with the chairman on that point. We will hear from the chairman of the Committee.

Mr. E. C. Brown (Union Railroad):—We were instructed last year to add to the cement specifications a provision for the testing of cements in connection with sand. This was done tentatively, but in view of the more recent action on the part of the Board of Direction, as has been outlined by the President, we thought it would be advisable, probably, to omit all discussion on the subject of cement specifications this year. In connection with other duties which were laid out for us, we revised and extended somewhat our list of definitions, which list, as it was brought in a year ago, was adopted with some modifications. It would seem to me that, if time will permit, the proper method of procedure would be to take up that list, unless the convention would prefer to spend what time we have on the subject of concrete specifications. That subject last year was merely touched on at the end of the discussion, and only one item, that headed "Consistency," was brought up at all. That was somewhat hurriedly decided, possibly in view of the discussions the Committee has received. If it is the pleasure of the convention, we will pass over the definitions for the present and take up the concrete specifications.

Prof. W. D. Pence (Purdue University):—I should like to inquire by what means we shall be able to discuss the subject of reinforced concrete? Shall it be discussed in connection with the subject of concrete itself? There is no resolution covering that subject. What has the Committee in mind?

Mr. E. C. Brown:—We have introduced an item in our concrete specifications touching on that topic. That is the only thing in concrete form that we have laid down.

The President:—Before taking up the question what we are to consider, I wish to call the attention of the Committee to the fact that they have misconstrued the instructions of the Board with regard to the sand matter. Their instructions were not sand for testing, but specifications for sand fit to use in making concrete. I want to call the attention of the Committee to the fact that they misunderstood these instructions.

(Mr. F. H. McGuigan in the chair.)

Mr. E. C. Brown:—In reply to what the President has said, I think the understanding of the Committee was in error, no doubt, for personally I know my understanding was that the sand was to be used for the sand tests of cement. However, we do in our specification for concrete define a character of sand suitable to be used in concrete work.

Mr. Walter G. Berg (Lehigh Valley):—I understand the question under discussion now is as to what part of this report to take up in view of the short time available for the consideration of it, and I would ask the chairman to give his views for the Committee, whether it is preferable to take the time on definitions or on the concrete. I do not think we can possibly handle both. I think we must be guided by the opinion of the Committee as to which would be the most valuable.

Mr. E. C. Brown:—It seems to be the unanimous opinion that the concrete specifications are perhaps more important, and if it is the pleasure of the convention, we should probably take that matter up and consider the specifications item by item.

Chairman McGuigan:—It has occurred to me that the discussion of concrete specifications would be a little premature in view of what President McDonald has said as to the special committee appointed to determine the character of concrete.

Professor Pence:—As I understood that point, it related to the specifications for cement and not concrete.

Chairman McGuigan:—Cement is such an important factor in making concrete it would seem to me that we must first determine the character of cement in order to prepare the best specifications for concrete; however, I am not a concrete expert, therefore do not feel entirely competent to express an opinion as to the best methods of handling.

Mr. Berg:—I move that the concrete specifications be taken up item by item.

(The motion was carried.)

The Secretary:—"Cement. Cement shall be Portland, either American or foreign, which will meet the requirements of the standard specifications."

(Adopted.)

The Secretary:—"Sand. Sand shall be clean, sharp, coarse, and of grains varying in size. It shall be free from sticks and other foreign matter, but it may contain clay or loam not to exceed five (5) per cent. Crusher dust, screened to reject all particles over one-quarter inch in diameter, may be used instead of sand if approved by the engineer."

(Adopted.)

The Secretary:—"Stone. Stone shall be sound, hard and durable, crushed to sizes not exceeding two inches in any direction. For reinforced concrete sizes usually are not to exceed three-quarter-inch in any direction, but may be varied to suit character of reinforcing material."

(Adopted.)

The Secretary:—"Gravel. Gravel shall be composed of clean pebbles

of hard and durable stone, of sizes not exceeding two inches in diameter, free from clay and other impurities except sand. When containing sand in any considerable quantity, the amount per unit of volume of gravel shall be determined accurately, to admit of the proper proportion of sand being maintained in the concrete mixture."

Mr. E. C. Brown:—Since the publication of the Bulletin the Committee desires to alter the specification for gravel very slightly. After the word "diameter" in the second line insert "and shall be," and in the fourth line, after the word "amount," insert the words "of sand," so that it will read: "Gravel shall be composed of clean pebbles of hard and durable stone of sizes not exceeding 2 inches in diameter, and shall be free from clay and other impurities except sand. When containing sand in any considerable quantity, the amount of sand per unit of volume of gravel shall be determined accurately, to admit of the proper proportion of sand being maintained in the concrete mixture."

(Changes adopted.)

Mr. W. C. Cushing (Pennsylvania Lines):—I do not want to make any remarks on gravel, but you passed the item of "stone" before I noticed there was no provision for screening. That is a point considerably discussed at the present time, viz., whether stone used for concrete should have the dust screened out of it. I infer from this definition that it is not intended to be, and my feeling is that it should be—I do not like to have all the dust in it—but there is a good deal of difference of opinion, and I simply want to express mine.

Mr. E. C. Brown:—We have left it optional with the engineer, at least that is the intention on our part. The Committee recognizes there has been a great deal of discussion pro and con on that subject, and the Committee itself even was divided, so that we thought a short way out was to say nothing about it.

Mr. Cushing:—I do not wish to make any motion. I ask the question to find out if there was any information to be had on this subject in the way of expressions from the members.

Mr. E. C. Brown:—We refer to "crusher dust" in connection with sand. There, under the allowance of the engineer the crusher dust to be used as sand is recommended. Following that up, the engineer would further be allowed to leave the crusher dust in the stone without the expense of screening it.

Professor Pence:—We have in our convention those who are especially interested in reinforced concrete and who are competent to speak on that subject from a practical point of view. I see this item refers to that class of concrete. There is also a special clause at the end of the specifications, relating to reinforced concrete, but if you pass points of that kind we shall find it difficult to discuss the subsequent clauses.

Mr. H. W. Parkhurst (Illinois Central):—I think the specification

of the size of the crushed stone places it at too small a figure, no dimension larger than ¾ inch. I think a large proportion of concrete work is done with a coarser stone.

Chairman McGuigan:—That is for reinforced concrete.

The Secretary:—"Water. Water shall be clean and reasonably clear, free from sulphuric acid or strong alkalies."

(Adopted.)

The Secretary:—"Mixing by Hand. (1) Tight platforms shall be provided of sufficient size to accommodate men and materials for the progressive and rapid mixing of at least two batches of concrete at the same time. Batches shall not exceed one cubic yard each, and smaller batches are preferable, based upon a multiple of the number of sacks to the barrel.

"(2) Spread the sand evenly upon the platform, then the cement upon the sand and mix thoroughly until of an even color. Add all the water necessary to make a thin mortar and spread again; add the gravel if used, and finally the broken stone, both of which, if dry, should first be thoroughly wet down. Turn the mass with shovels or hoes until thoroughly incorporated, and all the gravel and stone is covered with mortar; this will probably require the mass to be turned four times.

"(3) Another approved method, which may be permitted at the option of the engineer in charge, is to spread the sand, then the cement, and mix dry, then the gravel or broken stone; add water and mix thoroughly as above.

"Mixing by Machine. A machine mixer shall be used wherever the volume of work will justify the expense of installing the plant. The necessary requirements for the machine will be that a precise and regular proportioning of materials can be controlled and the product delivered be of the required consistency and thoroughly mixed."

Mr. E. C. Brown:—The Committee also wishes to make a slight alteration in the reading of the clause "mixing by machine," so that the sentence will read: "The necessary requirements for the machine will be that a precise and regular proportioning of materials can be controlled and that the product delivered shall be of the required consistency and thoroughly mixed."

(The alteration was adopted.)

The Secretary:—"Consistency. The concrete shall be of such consistency that when dumped in place it will not require much tamping. It shall be spaded down and tamped sufficiently to level off, after which the water should rise freely to the surface."

Mr. E. C. Brown:—Under the specification on "Consistency," substitute the word "and" in the third line for the words "after which." This was the clause which was acted upon a year ago, the wording of which was slightly changed, but not the intent.

(The alteration was adopted.)

The Secretary:—"Forms. (1) Forms shall be well built, substan-

tial and unyielding, properly braced or tied together by means of wire or rods, and shall conform to lines given.

"(2) For all important work the material used shall be dressed lumber, sound and free from loose knots, secured to the studding or uprights in horizontal lines.

"(3) For backings and other rough work undressed lumber may be used.

"(4) Where corners of the masonry and other projections liable to injury occur, suitable moldings shall be placed in the angles of the forms to round or bevel them off.

"(5) Planking once used in forms shall be cleaned before being used again.

"(6) The forms must not be removed within thirty-six hours after all the concrete in that section has been placed. In freezing weather they must remain until the concrete has had a sufficient time to become thoroughly set.

"(7) In dry but not freezing weather, the forms shall be drenched with water before the concrete is placed against them."

Mr. Berg:—"For backings and other rough work undressed lumber may be used."

Mr. E. C. Brown:—That would be included under "other rough work," would it not?

Mr. Berg:—Yes. I think the second clause, "Materials should be dressed lumber, dressed on one side," should be "dressed on both sides."

Mr. E. C. Brown:—No, that does not matter.

Mr. W. B. Poland (Baltimore & Ohio Southwestern):—If the lumber for the forms is dressed on but one side, you have no assurance that the material will be of the same thickness; as a matter of fact it is not of the same thickness; frequently it will vary as much as a quarter of an inch. The unsized side of the lumber is against the uprights; therefore the dressed side, against which the concrete is placed, is an uneven surface and frequently results in a bad surface on the finished work unless you specify that the form lumber shall be dressed to an even thickness. It is immaterial whether it is dressed on both sides or not, but it is important that it be dressed to an even thickness, so that the face against which the concrete is molded shall be a uniform surface.

The President:—The chair, without formal action, will consider the motion passed to reconsider and go back to No. 2.

Mr. T. L. Condron (Consulting Engineer):—I move that the second paragraph be modified in this way: "That for all important work the lumber shall be sized one side to uniform thickness, or dressed on both sides, at the option of the engineer."

Mr. J. W. Schaub (Consulting Engineer):—I never saw a mill turn out lumber, dressed on one side, that was not of uniform thickness; there is no necessity for dressing it on both sides.

Mr. Condron:—I think the ordinary term "dressed" refers to lumber dressed on all sides.

Mr. Schaub:—That leaves it to the option of the engineer, whether he wants it dressed on all sides.

Mr. McGuigan:—If the lumber is dressed for a special purpose you might find yourself in a position where you would be compelled to use lumber dressed at two or more mills for entirely different purposes, therefore I think the thickness should be specifically stated.

The President:—The Committee proposes to change that to read: "For all important work the material used shall be lumber dressed to a uniform thickness, sound and free from loose knots." Is that satisfactory to the convention?

Mr. B. Douglas (Michigan Central):—I think it should be specified that the edges of plank for face work should be dressed.

Professor Pence:—Let it stand as it is—"shall be dressed lumber," and then insert "sized to a uniform thickness."

The President:—Sizing necessarily carries with it the uniform thickness idea, but the difficulty is that no provision has been made for dressing the edges.

Mr. Parkhurst:—The general expression is "sized," and it is written "S 1 S," and it means size on one side of uniform thickness. That is the usual understanding. I think the motion made by Mr. Condron covers the point better than any other way, because in nicer work we want the material edged as well as sized. In work of less fine character you want one side dressed so as to make a smooth finish, and there may be other variations in carpenter work which can be specified by the engineer, and indicated in the specifications as Mr. Condron suggested.

The President:—Mr. Condron, we would like to have you state your motion again.

Mr. Condron:—"For all important work the material used shall be lumber sized one side to uniform thickness or dressed on all sides, at the option of the engineer, sound and free from loose knots," etc.

Mr. H. G. Kelley (Minneapolis & St. Louis):—Any man ordering lumber—take, for instance, 1 by 6-16, if he order it 1 by 6-16, he will get the rough output of the mills, which may be a little over 1 inch thick—usually a little less. If he wants it dressed on one side he orders it 1 by 6-16, S 1 S, and there will be no mistake. If he wants it a little better he orders it 1 by 6-16, S 1 S and 2 E. That means dressed on one side and two edges, the width being immaterial. The alteration proposed by Mr. Condron would place us in a position of going to an additional expense of ordering lumber dressed on four sides, known to the mills as S 4 S. It seems to me the paragraph as first written—"the material used shall be dressed lumber"—is not confined to dressed lumber, edged on two sides or four sides, and you could save the company and the contractor money by adjusting the order in a particular case to the results desired.

Mr. Parkhurst:—I think the general understanding of the phrase

"dressed lumber" would be S 4 S, that is, sized on four sides. This is the criticism to be made of the specification now. It would not be understood by all alike.

The President:—The question is on the amendment of Mr. Condron, that it be left to the option of the engineer. The amendment proposed by Mr. Condron is before you.

(The amendment was carried.)

The President:—The chair will state in a few minutes how that amendment reads. The Committee is desirous of having a chance to vote on that question. Some gentlemen who have voted in the affirmative should be magnanimous enough to allow it.

(A motion to reconsider was made and carried.)

The President:—The question is on the amendment of Mr. Condron.

Mr. C. F. Loweth (Chicago, Milwaukee & St. Paul):—It seems to me we cannot get a good face unless the material of which the forms are made is surfaced on the edges, which should be clearly expressed in this specification. I think it will be well to modify this clause to read: "In all important work the lumber shall be dressed on one side and both edges, uniform thickness and width," etc.

The President:—The Committee accepts that amendment.

Mr. Berg:—I move that the word "faced" be inserted after "important."

Mr. Kelley:—Mr. Berg's proposed amendment reads "For all important work the lumber used for face work shall be," etc.

Mr. Loweth:—I think it should read "One side and both edges to be of uniform thickness and width," instead of "uniform thickness."

Mr. Poland:—There may be some high class work where it is desirable to have the form boards of uniform width, but I believe in the majority of cases that is immaterial. The boards are frequently laid to a common vertical line where it is not important whether the separate boards are of uniform width or not. Where the work is important a special specification could be made by the engineer to cover this point, but if we say this lumber must be of uniform width, it will greatly increase the cost of the material unnecessarily. I, therefore, move as an amendment that the word "width" be stricken out.

The President:—We will revise it as you desire.

Mr. Kelley:—It will prevent breaking joints with the lagging that we use, if the lumber is not of uniform width.

Mr. Loweth:—The character of the work the gentleman refers to is covered in the next clause. I cannot conceive of any work that is important enough to require a good face, where the expense of dressing the lumber as I have suggested would not be justified.

The President:—The question is on the amendment to the amendment.

(The amendment to the amendment was lost.)

The President:—The question is on the amendment. The Secretary will read it in its original form.

The Secretary:—"For all important work the material used shall be lumber sized one side to uniform thickness or dressed on all sides, at the option of the engineer, sound and free from loose knots, secured to the studding or uprights in horizontal lines."

Mr. Parkhurst:—I would suggest that the words "and shall be sound" be inserted after the phrase "uniform width."

Mr. Condron:—I accept the amendment.

(Mr. Condron's amendment was voted on and carried.)

The President:—The clause as amended is substituted for the original.

Mr. McGuigan:—In clause 5, I move that the word "lumber" be substituted for "planking," as a plank is a piece of timber known to be about two or three inches thick.

The President:—The Committee accepts that.

The Secretary:—"Disposition. (1) Each layer should be left somewhat rough to insure bonding with the next layer above; and, if it be already set, shall be thoroughly cleaned and scrubbed with coarse brushes and water before the next layer is placed upon it."

"(2) Concrete shall be deposited in the molds in layers of such thickness as shall be specified by the engineer in charge. It must, however, be spread in layers at right angles to the lines of pressure, and temporary planking placed at ends of partial layers, so that none shall run out to a thin edge. Excepting in arch work, all concrete must be deposited in horizontal layers of uniform thickness throughout. The ends, where a full layer cannot be laid at the time, shall be squared off by vertical temporary planking."

Mr. E. C. Brown:—The Committee wishes to make an alteration in paragraph No. 2, changing it to read as follows: "Concrete shall be deposited in the molds in layers of such thickness and position as shall be specified by the engineer in charge;" then omit a little more than a line, "and temporary planking"—shall be—"placed at ends of partial layers, so that none shall run out to a thin edge. In general—"excepting in arch work, all concrete must be deposited in horizontal layers of uniform thickness throughout." Strike out the last two lines.

The President:—Is there any discussion on the Committee's proposed alteration?

(The alteration was accepted.)

The Secretary:—"(3) The work should be carried up in sections of convenient length and the sections completed without intermission."

Mr. Berg:—Would it not be better to change that to "shall be" instead of "should be?"

The President:—The Committee accepts that change.

The Secretary:—"(4) In no case shall work on a section stop within 18 inches of the top."

"(5) Concrete shall be placed immediately after mixing and any having an initial set shall be rejected."

Mr. John V. Hanna (St. Louis & San Francisco):—I would suggest that paragraph No. 5 be made to read: "And any having an initial set before being placed shall be rejected and removed from the work." Insert "before being placed" after "set."

The President:—The Committee is undecided on that. Do you make that as a motion?

Mr. Hanna:—Yes.

(The motion was lost.)

The President:—The question now is on the original draft by the Committee.

(Adopted.)

Prof. G. F. Swain (Massachusetts Institute of Technology):—There is a slight change in No. 3, which could be made, and it would improve it a little. "Work shall be"—"and each section completed without intermission."

The President:—The Committee will accept that.

The Secretary:—"Expansion Joints. (1) In exposed work expansion joints may be provided at intervals of fifty to one hundred feet or as the engineer may direct.

"(2) A temporary vertical form or partition of plank shall be set up and the section behind completed as though it were the end of the structure. The partition will be removed when the next section is begun, and the new concrete placed against the old without mortar flushing. Locks shall be provided if directed or called for by the plans.

"(3) In reinforced or steel concrete the length of these sections may be materially increased at the option of the engineer."

Mr. Cushing:—Has the Committee any experimental information to support the recommendations of paragraphs 1, 2 and 3? We have some experience in that matter which leads us to believe that 30 feet is long enough for a section.

The President:—That is a very important point.

Mr. Parkhurst:—I examined the retaining wall which is now under construction at the city of Galveston, and they have something like 2½ miles of it finished. It is divided into sections 50 to 55 feet in length, and is built in alternate sections, leaving a space, and after three or four sections are built they go back and fill in the opening. They make dovetail expansions on it. The day I examined the work the thermometer was near the freezing point, consequently the concrete had about as much contraction as it would be likely to have. In a number of cases I found a joint ⅜ inch wide. I found a very few of the consecutive sections open; they seemed to hold together by adhesion, although no special pains were taken to cement the sections together. There would be two or three close together, with no joints showing at all, and then there would be one with an opening of ⅜ inch, sometimes more. In a number of sections I counted three or four places where there would be no joints. The expansion had taken place, possibly due to some set-

tlement. It is difficult to say why all should not have acted alike, as the foundation is on piles and very heavy. I would, therefore, advocate making expansion joints at frequent intervals, especially if the work is built in warm weather.

The President:—Mr. Churchill, we would like to hear from you on that matter.

Mr. Churchill:—I have one case in mind, an arch under a 70-foot bank that was put in two years ago without any expansion joints, the idea being that the bank was high enough to keep the temperature nearly uniform, but expansion cracks developed vertical to the side walls, running up through the arch; they were not at all injurious, but proved to my mind that expansion joints should be established about every 45 feet. In other words, if any arch is over 90 feet in length, I would put one expansion joint in it, and in case of a continuous wall expansion joints should be spaced about every 45 feet.

Mr. Schaub:—In building the foundation walls for a building about 550 feet long, the walls were exposed above the surface of the natural ground, because the fill had not been made. These walls were exposed for several days after removing the forms, and it was found that a crack appeared about every 50 feet, and it invariably occurred in lines of least resistance; but the expansion had nothing to do with it. It was the shrinkage of the concrete exposed to the air which caused the cracks. I think the matter of shrinkage is far more important than the question of expansion. We now build all our walls with expansion joints 50 feet apart, and we build the end of wall to serve as a form for the next section. This gives all the opening necessary to provide for expansion.

Mr. Kelley:—In this connection I would like to speak upon the necessity of providing expansion joints at frequent intervals, probably within limits of 50 to 30 feet. The coefficients of expansion of steel and concrete are practically the same within short lengths, or, in the case of steel, about 5-16 of an inch in lengths of 30 feet, due to differences of temperature in our Northern climate. Would any contractor design a structure in steel without providing for such expansion? In my own case recently a roundhouse had been designed in brick and contract placed, when, owing to strikes, it was impossible to obtain brickwork without serious delay, and authority was given to proceed with the construction in concrete block work. The modification in design was made in the field by the contractor and supervisor in charge, using 10-inch hollow blocks for the walls, and solid concrete for the pilasters, no allowance being made for expansion joints. When the temperature fell to 35° below zero in the winter, the roundhouse not being heated or occupied at that time, slight cracks appeared in the rear panels, following the line of least resistance above and below the window openings. There was no settlement or separation of masonry. The distance between pilasters was about 26 feet, and the cracks opened a maximum of 1-16 of an inch. With

the heating of the roundhouse and advent of warmer weather, the cracks entirely disappeared. In another concrete building about 200 feet long, the design was prepared providing for expansion joints at intervals of not to exceed 25 feet.

Mr. Berg:—It seems to me this is a principle of designing depending upon the construction and the designing engineer, and more properly shown on the plan, or as the engineer may direct during the conduct of the work. I move that the clause read: "In exposed work expansion joints shall be provided at such intervals as the engineer may prescribe."

Mr. Churchill:—I offer an amendment to that to the effect that, "In exposed work expansion joints may be provided at intervals of not more than 50 feet, or as the engineer may direct."

(The amendment to the amendment was lost.)

(The question on the original motion of Mr. Berg was lost. The question on the original clause prepared by the Committee, No. 1, was next taken up.)

Mr. Kelley:—I move to substitute for that the following: "In exposed work expansion joints shall be provided at intervals of not more than 50 feet, or as the engineer may direct."

Mr. Loweth:—It seems to me that we ought not to require an expansion joint every 50 feet, irrespective of the kind of structure; a joint every 60, 80, or even 100 feet in a straight wall or an abutment would probably be sufficient. Such structures are usually of such great thickness, and so exposed, that they are not easily affected by changes of temperature.

Mr. Kelley:—I said "shall be provided at intervals of not more than 50 feet, or as the engineer may direct," giving in the first place what the engineer considers the limit for ordinary work. If the engineer's experience justifies his going beyond that, he may do so. It is left to the engineer to decide what he will do, but it gives him information when he seeks for it.

Mr. McGuigan:—It has occurred to me as a way out of the difficulty to have the paragraph read as follows: "In exposed work, expansion joints may be provided at intervals of 30 to 100 feet, as the character of the structure may require."

The President:—You move to amend this clause by substituting 30 instead of 50? Without objection the amendment will be passed, that is, that 30 be substituted for 50 in paragraph 1. Are you willing to let that remain, "as the engineer may direct?"

Mr. McGuigan:—If I were doing the job I might conclude that 30 to 35 feet would be about the proper distance to provide for expansion. A lot of very capable people are in charge of concrete work who are not engineers.

(The amendment offered by Mr. McGuigan was voted on and was adopted.)

Professor Pence:—The coefficient of expansion of concrete is not as closely in agreement with that of steel as stated by Mr. Kelley. It is rep-

resented by .0000055, while steel is .0000065 to .0000070. I have just made a calculation on that basis in regard to the case Mr. Kelley spoke of, and I find the contraction would be about 3-16 of an inch with a change of temperature from 65 above to 35 below zero. As cold as roundhouses usually are, I think we would have the wall chilled through with several successive days of 35 below zero. A retaining wall would have very much less range with earth back of it. Between the case referred to at Galveston, and the one Mr. Kelley refers to, there would be quite a difference, of course.

Mr. Kelley:—The difference in temperature was excessive; it was 85 to 90 during the time the blocks were made and the house built, and 35 below zero when the crack appeared.

Mr. McGuigan:—I should like to ask Mr. Kelley if his house was heated; if so, with the temperature 60 to 70 degrees on the inside and 35 below on the outside, how the wall cracked.

Mr. Kelley:—The house was not heated when the crack appeared.

Mr. E. C. Brown:—In paragraph 2 change the word "will," the fourth word in the third line, making it read "shall."

(Adopted.)

The Secretary:—"Facing.—(1) A shovel facing may be made by carefully working the coarse stone back from the form by means of a shovel or spade so as to bring the excess mortar of the concrete to the face. Or,

"(2) About one inch of mortar (not grout) of the same proportions as used in the concrete shall be placed next to the forms immediately in advance of the concrete.

"(3) Care must be taken to remove from the forms the dried mortar which spatters against them, in order to secure a perfect face."

Mr. E. C. Brown:—In item 2, under "facing," we wish to change the word "shall" to "may," in the second line.

The President:—The chair understands the convention agrees to that.

Mr. Loweth:—I move to amend by substituting for the words "A shovel facing may," the words "The facing will," and in the second line the word "material" for "stone:" also in the same line by substituting "A shovel, bar or similar tool" in place of "A shovel or spade:" thus making the clause read as follows: "The facing will be made by carefully working the coarse material back from the form by means of a shovel, bar or similar tool, so as to bring the excess mortar of the concrete to the face."

(Accepted by Committee.)

The President:—Without objection, the other clauses will be considered as adopted.

The Secretary:—"Finishing.—(1) After the forms are removed, which should generally be as soon as possible after the concrete is sufficiently set, any small cavities or openings in the face shall be neatly filled with mortar if necessary. Any ridges due to cracks or joints in the lumber shall be rubbed down with chisel or wooden float. The entire face may then be washed with a thin grout of the consistency of whitewash, mixed in the

same proportion as the mortar of the concrete. The wash should be applied with a brush. The earlier the above operations are performed, the better will be the result.

"(2) The tops of bridge seats, pedestals, copings, wing walls, etc., when not finished with natural stone coping, shall be finished with a smooth surface composed of one part cement to two parts of granite, or other suitable screenings, or sand applied in a layer ½ to 1 inch thick. This MUST be put in place with the last course of concrete."

Mr. Loweth:—It seems to me that paragraphs 1 and 2 are unnecessary requirements, if they refer to all the faces; if they refer only to the exposed face of the concrete structure, they are all right.

The President:—The Committee will introduce the word "exposed" in the fifth line at the top of paragraph 1, making it read "the entire exposed face."

Professor Swain:—It seems to me "if necessary" is indefinite. It ought to be, "if necessary in the opinion of the engineer."

The President:—The Committee desires to make that change.

Mr. McGuigan:—We got away from clause 3 before I had time to make the following suggestion, which I now offer: "Care must be taken before filling to remove from the forms dry mortar, in order to secure a perfect face."

(Accepted by Committee.)

Mr. Parkhurst:—I understand the specifications would require that this coating work, whitewash, etc., be done. I think there is a great deal of work done without having that done at all, and I doubt if it is advisable to put it in the specifications. I think it should be understood that this is a permissible method of finishing and doubtful in its results.

The President:—That is a very interesting question Mr. Parkhurst has just called to the attention of the Committee. The tendency of to-day is to finish the face without applying the coating. The question before the house is the clause on "Finishing." We would like to hear from Mr. Scribner on the question of finishing concrete without coating on the outside. Mr. Scribner was the contractor for the Big Muddy arch bridge on the Illinois Central.

Mr. G. H. Scribner, Jr:—I think the grout whitewash is not necessary in railroad work. I have seen some specifications lately where it was required that the plank molds should be removed and the facing mortar rubbed to insure a good surface.

Mr. Parkhurst:—In connection with this subject I may be pardoned for stating that our company has done something like half a million dollars' worth of concrete work and the finishing has invariably been obtained by putting mortar facing next to the molds and taking the molds off after a reasonable time, simply pointing up such little porous holes or crevices as might exist because of the construction of the molding.

The President:—I think it takes a man who is unusually expert to do that work, to determine the right condition of moisture and proper thickness of grout. Men of that character are very hard to find. Mr. Meade, of

the Santa Fe, is present, and we would be glad to have him give his experience.

Mr. J. M. Meade (Atchison, Topeka & Santa Fe):—The case I have in mind is a concrete dam recently built in Oklahoma on the Santa Fe, and the back of it was built up plumb, with a curved exterior face, and to save expense we used rough plank of different thicknesses. When the plank was pulled off the back was a little honeycombed. We did not think that was very good for water. The whole face was rough. We got some whitewash brushes, put on a couple of laboring men and went over it, I think three times (the dam was 120 feet long), at very small expense, so that we took all of the impressions of the plank and all the honeycomb places out with the grout; and the dam now presents the appearance of a piece of concrete as smooth as a piece of pottery. I think we have overcome the likelihood of having the dam leak from those honeycomb places. I believe brush grouting is the proper thing to do.

Mr. E. C. Brown:—I would like to add my own experience to this question. I have very successfully washed my concrete faces with very thin grout. I have some now finished three years ago in that way. The work was done under the direction of an unusually skillful man and there has been no tendency to scale off with this grout wash. The only precaution we found necessary was that the grout should not be too rich nor too thick, and I have since then used rough lumber for my face work, as well as for the backing, almost exclusively, and depended upon this method of smoothing it up or finishing it, and it has proven very successful.

My attention is called by another member of the Committee to the fact that we have defined in these definitions the word "face" as "the exposed surface of the wall," which perhaps would relieve us of the necessity of introducing that word "exposed" before the word "face" where it occurs twice in this paragraph.

The President:—The Committee withdraws its consent to put in that word "exposed" as proposed once before. The gentleman who suggested it is, I think, Mr. Loweth. Are you ready for the question as submitted in print, without any alterations except the addition of the words "in the opinion of the engineer" after the word "necessary?"

(Clause adopted.)

The President:—The word "shall" in the fourth line from the top, in order to make it agree with the language of the Committee, is changed to "may" without objection.

Mr. Loweth:—I move to amend paragraph 2 by striking out the emphasis on the word "must" in the last line, and place it in ordinary type. Should we emphasize that any more than a hundred other such words in these specifications?

Mr. E. C. Brown:—We think it absolutely necessary, to get a good job, that the finishing course MUST be put on with concrete.

Mr. Loweth:—Are there not a hundred other things in the specifications just as necessary?

(The motion was carried.)

The Secretary:—"Waterproofing.—A thin coat of mortar or grout shall be applied for a finishing coat, upon which shall be placed a suitable covering of asphalt."

Mr. Berg:—Relative to waterproofing, does that confine waterproofing to asphalt? Should it not be qualified "or as otherwise may be directed or prescribed by the plans?"

Mr. Parkhurst:—It seems to me that the clause as it stands is open to the very serious objection that it describes the particular thing to accomplish a certain object, while there may be something else. It shuts out competition, which we certainly do not want to do, and I think the specification should be drawn up with reference to the possibility of something else being found which can be used for the same purpose.

Mr. E. C. Brown:—We are willing to say: "Covering of waterproof material," leaving it more indefinite. We are rather anxious that the specification should be completed, and think that rather than have the clause referred back to the Committee we would be willing to strike out the paragraph entirely for the present. But our preference is to substitute other words for the word "asphalt"—for instance, "waterproofing material."

The President:—The Committee has offered a bone to the convention by agreeing to add "waterproofing material."

Mr. Parkhurst:—That covers the point which I raised.

The President:—The amendment proposed by the Committee would then read as follows: "A thin coat of mortar or grout shall be applied for a finishing coat, upon which shall be placed a covering of suitable waterproofing material."

Mr. Kelley:—I wish to vote for the substitute, but is it not a little too direct in the first part? As it stands now it is a general clause in this specification, which would apparently mean that all concrete must be waterproofed. I move to add the words at the beginning of the clause as follows: "Where waterproofing is required."

(The motion carried.)

The President:—The next question is on the diagram as submitted by the Committee.

(Adopted.)

The Secretary:—"Freezing Weather.—Ordinarily concrete to be left above the surface of the ground will not be constructed in freezing weather. Portland cement concrete, however, may be built under these conditions by special instructions. In this case the sand, water and broken stone shall be heated, and in severe cold salt shall be added in the proportion of about 2 lbs. per cubic yard."

The President:—The chair thinks that salt being added in the proportion of about two pounds per cubic yard is indefinite. It appears to me it should be in the proportion of the number of gallons of water.

Mr. Condron:—The use of salt in reinforced concrete is generally considered to be injurious, and therefore, as the specification covers both plain and reinforced concrete, unless it is referred to in the following par-

agraphs, and that should be objected to, the use of salt should be restricted to plain concrete.

Mr. E. C. Brown:—I will say that the Committee is not prepared to say how much salt per gallon of water is necessary; at least, I am not; some of the other Committee members may be.

Mr. Cushing:—I have here the proportion as given in Professor Johnson's book, which is the most generally accepted authority: "One pound of salt to 18 gallons, with a temperature of 32 degrees F. Add one ounce of salt for every degree of temperature below 30 degrees."

The President:—I have looked into this question and have tried to apply that mixture of Professor Johnson's. I had a test made and had a number of cans of water set out and mixed with various proportions of salt, and I found at zero weather it took one pound of salt to one gallon of water to keep the water from freezing over on top.

Mr. E. E. Hart (New York, Chicago & St. Louis):—During the past ten or fifteen years I have been having something to do with this question. I have found it is the safest way to use all the salt you can put into the water; have the tank large enough so that you can put in a surplus of salt, let the water run into the tank and fill it, stirring it by steam, and in this way we never have had any trouble in cold weather in putting in concrete.

Mr. G. H. Scribner, Jr.:—The work I have been doing this winter is reinforced work and we did not use any salt. We heated the sand, stone and water to a temperature of 90 degrees.

Mr. D. MacPherson (Canadian Pacific):—Is not that the best way to do it—to heat the materials you put into concrete?

(Adopted.)

The Secretary:—"Reinforced Concrete.—Where concrete is deposited in connection with metal reinforcing, the greatest care must be taken to insure the coating of the metal with cement, and the thorough compacting of the concrete around the metal. Wherever it is practicable, the metal should be placed in position first. This can usually be done in the case where the metal occurs in the bottom of the forms, by supporting the same on transverse wires, or otherwise, when the bottoms of the forms can be flushed with cement mortar, so as to get the mortar under the metal at the same time, and the concrete deposited immediately afterward. The mortar for flushing the bars should be composed of one part cement and two parts sand. The metal used in the concrete shall be free from dirt, oil or grease. Rust is not objectionable, but all mill scale should be removed by hammering the metal, or preferably by pickling the same in a weak solution of muriatic acid. No reinforced concrete shall be laid in freezing weather."

Mr. R. Modjeski (Consulting Engineer):—I would be in favor of striking out the words, "Rust is not objectionable." When the matter is not mentioned in the specifications, it is understood that rust is not objectionable.

Mr. Kelley:—Before taking a vote on that, I suggest calling on Professor Hatt and Mr. Schaub to give us their opinions on the subject.

Prof. W. K. Hatt (Purdue University):—I have not an opinion of any value on that particular point.

Mr. Schaub:—There have been some experiments made by imbedding rusty bars in mortar that have shown conclusively that the mortar eats up the rust and leaves the bar clean, so that rust cannot be objectionable on bars for reinforced concrete. I do not think there is any question about that. Concrete is technically and physically the most absolute protection we have against rust. It is anhydrous and it is alkaline, two of the most violent foes to rust. Metal that is imbedded in concrete which is properly waterproofed should never deteriorate through rust.

Mr. Modjeski:—I do not mean to convey the idea that there is any objection to rust in small quantities, but the words may be interpreted that no amount of rust is objectionable. In that case, we may not have the amount of metal left that we need.

(Mr. Modjeski's motion to strike out the words "rust is not objectionable but" was carried.)

Mr. Parkhurst:—I move that the last line, which reads, "No reinforced concrete shall be laid in freezing weather," shall be stricken out.

Mr. Schaub:—You would have to put metal in the water, and that would freeze the water instantly. Unless you heat the metal it is going to freeze the water. How will you get around that difficulty?

Mr. Parkhurst:—The term "freezing weather" is an indefinite one. It might possibly do to have the expression read: "No reinforced concrete shall be laid in weather when the temperature is below, say, 15 degrees or 10 degrees," but the general expression as it stands is wrong. We have been building reinforced concrete this winter in temperatures 10 to 15 degrees above zero, by heating the sand, water and stone, and in one or two cases by surrounding the work with steam pipes we have done some very necessary work in very cold weather. We believe it to be entirely successful. We have some experiments in progress in which we have buried pieces of corrugated bar in masses of concrete and put them right out to freeze, and the present indications are that we are going to get a substantial grip between the concrete and steel, although it has been frozen a lot since then.

Mr. Condron:—We have with us Mr. Cartlidge, the Bridge Engineer of the Burlington, who has been putting in reinforced concrete this winter. I suggest that he be asked to give us his experience.

Mr. C. H. Cartlidge (Chicago, Burlington & Quincy):—The work that Mr. Condron refers to was put in in extremely cold weather; as a matter of fact, some of the concrete was deposited at temperatures somewhat below zero. It was all heated—sand, stone and water. We used no salt and we were anxious to know what the effect of the heating would be. We found the temperature went up as high as 90 degrees. We made a good many observations on the concrete and found that as late as 24 hours after it had been placed it had not reached the freezing point. It

had set some hours before that time. It seemed to us that no danger could result from that sort of work, and we continued it in all sorts of weather, taking means to cover it over at night.

(Mr. Parkhurst's motion was carried.)

Mr. Modjeski:—I should like to see a clause inserted to the effect that no salt be used when reinforced concrete is being laid in freezing weather, as the salt may affect the metal. In fact, I think it does.

The President:—The Committee is willing to insert the words, "No salt will be used in reinforced concrete when laid in freezing weather."

Mr. W. W. Curtis (Consulting Engineer):—Mr. Moore, chemist of the R. W. Hunt Company, calls attention to the fact that if you soak the metal in dilute hydrochloric acid, it may be well to wash it off afterward.

(The paragraph on reinforced concrete as amended was adopted.)

REPORT OF COMMITTEE NO. I.—ON ROADWAY.

To the Members of the American Railway Engineering and Maintenance of Way Association:

The Committee on Roadway has acted upon the instructions of the Board of Direction, contained in Bulletin No. 40, dated May, 1903, and herewith submits its report.

The form of Specifications, as submitted at the last convention, has been carefully revised and abbreviated as far as consistent, and it is believed that the general principles embodied therein can be applied or conveniently modified to suit every condition connected with the construction of roadway, on any part of this continent.

One special feature in regard to abbreviation is the elimination of the constant reference to the direction, judgment, approval, decision, etc., of the engineer. It is the opinion of the Committee that the embodying of a clause in a contract, and in the general conditions, defining whose judgment, direction, etc., are meant, is sufficient, and would in no wise detract from the general strength of the Specifications.

Several matters referred to in the General Conditions may more properly belong to the contract itself; but it is the opinion of the Committee that such items bear so directly on the actual work as described, that their importance is emphasized by their insertion as a direct part of the Specifications.

Perusal of the historical sketch referring to railway location is invited in connection with an exhaustive Bulletin in regard to data derived from the results of experience in improvements on the lines of the Union Pacific Railroad, prepared under the direction of its Chief Engineer. This Bulletin is printed as an appendix to the report.

RAILWAY LOCATION.

HISTORICAL SKETCH.

It is interesting to note that as early as 1829, S. H. Long, of the Board of Engineers of the Baltimore & Ohio Railroad, issued a "Railroad Manual," in which the sharpness of curve was defined by the angle of deflection made between two chords of 100 feet each. This was called by him the "Primary Angle of Deflection" and is the same in amount as the "Degree of Curve" of more modern days. This apparently fixed the practice of laying out curves as it still exists in this country.

As early as 1837, a small book by S. W. Mifflin, Civil Engineer, definitely defines the "Degree of Curve" as the angle at the centre subtended by a chord of 100 feet.

The use of Easement Curves, too, seems to have been of early date,

for in 1837, Mahan, in his "Treatise on Civil Engineering," suggests that:

"In changing the direction from a straight to a curved track, it should be gradually effected, and it may be done by forming the curve of several arcs of circles of different curvature, which shall be tangent to each other at the points of passage from one to the other, the radii gradually decreasing from the arc which is tangent to the straight portion to that of the summit of the curve."

This practice prevailed on some of the eastern railroads, among them the Olneyville Branch of the New York, Providence & Boston Railroad, now part of the main line from Providence to Stonington and New London, and which was constructed in 1847 or 1848.

Rankine, in his "Civil Engineering," published in 1862, says under the head of "Method of Easing Changes in Curvature:"

"Every change of curvature should be accompanied by a change in the cant of the rails; and as changes of the cant of the rails can only be made by degrees, changes of curvature should be gradual also, whether they occur at junctions of curves with straight lines, or of curves of reverse curvature, or of different radii with each other."

"Two methods of setting out curves with gradual changes of curvature have been practiced—one, invented by Mr. Gravatt about 1828 or 1829, consists in the use of the curve of sines instead of the circle for railway curves; the other, invented by Mr. William Froude about twenty years ago" (making the date about 1841) "consists in adhering to the use of the circle throughout the greater part of the extent of each curve, but introducing at each end of each curve a small portion of a curve approximating to the *elastic curve,* for the purpose of making the change of curvature by degrees."

The "curve of sines" was not convenient for laying out and probably had little if any use in practice.

The "curve invented by William Froude" was in form and also in name the cubic parabola with which we are familiar in later days, and it was demonstrated by him in the Transactions of the Institute of Engineers in Scotland, Vol. IV, 1860-61, that the cubic parabola satisfied the requirements of substantially conforming to a uniform rate of increase in the cant of rails and a uniform increase in the sharpness of curvature of track between the tangent and the circular curve. The method of staking out was by offsets, and this form of curve was evidently in use on the South Devon Railway earlier than 1861—how much earlier does not appear.

Henck, in his "Fieldbook," published in 1854, called attention to the common (not cubic) parabola, as an easement curve, where he says:

"Methods of laying out parabolic curves are here given, that those so disposed may test their reputed advantages." . . . "Their curvature generally decreases towards both extremities, thus making the transition from a straight line easier. Some labor has been given to devising convenient ways of laying out these curves." . . . "Better processes, however, may already exist, particularly in France, where these curves are said to be in general use."

The parabola, however, seems not to have had any considerable use in this country, perhaps none at all outside of street car lines. The lack of convenience in laying them out probably discouraged their use.

The cubic parabola was laid out with reasonable convenience by offsets. Just when easement curves were first laid out by deflection angles may be uncertain, but the spiral of Elliot Holbrook came out in 1880, and the Searles' Spiral in 1882, and both of them were adapted to the use of deflection angles.

In the treatment of grades early practice showed a remarkable appreciation of many features that appeal to us now as advanced practice. On the earlier railroads, a strong effort was made to secure low grades, as explained by J. Knight, Engineer, in the Fourth Annual Report of the President and Directors of the Baltimore & Ohio Railroad in 1830, which says:

"The effective power on the Liverpool & Manchester Railway of a locomotive engine weighing 4½ tons is stated to be such as to enable it to draw after it 30 tons weight at the rate of 15 miles per hour on a level, and 7 tons at the same speed up an ascent of 1 in 96, or 55 feet to the mile." . . . "The same wagon would draw four wagons of three tons each up an ascent of about 30 feet per mile at the velocity mentioned, and hence the locomotive engine can be employed effectively on a railway that shall not ascend or descend more than about 30 feet per mile. This species of power will generally be applicable the whole distance of the Ohio, with the exception of a section on the Alleghany Mountains and two or three miles at Parr's Spring Ridge. These summits must be overcome with stationary steam power—a method which is in successful operation in Europe, and also on the works of the Hudson & Delaware Companies in Pennsylvania."

Again in 1827, in "Remarks Relative to a Railroad from Baltimore to the Ohio River, by Minus Ward, Civil Engineer," we find that:

"It has been stated by Gray and quoted by Strickland that a locomotive engine will work goods over an elevation of 27½ feet to the mile; they have taken care, however, not to tell what weight of goods could thus be 'worked over,' and omitted to make any calculations (which as engineers they should have done) to ascertain the quantity which could be taken over this elevation," etc. . . . "Now we undertake to say that this ascent is far too much," etc.

On the Columbia & Philadelphia Railroad, begun in 1832, "the maximum grade of the line was fixed at 30 feet per mile." At Mine Ridge Gap, on bad soil, a cut shallower than intended seemed necessary, and on this account the grade was raised to 45 feet per mile, and in another place 40 feet per mile.

As an indication of the views thus early entertained, the report of the Directors of the Boston & Worcester Railroad Corporation, in 1832, states that:

"The Baltimore & Ohio Railroad has frequent planes, besides those which are surmounted by stationary engines, of 40 feet per mile inclination. The Camden & Amboy Railroad between Philadelphia and New York has frequent planes of various rates of inclination from 35 feet to 45 feet per mile."

But it is certain that there were some, and perhaps many, who well understood that gradients much steeper than these were allowable, for one Thomas Earle, in 1830, sets forth that:

"Contrary to Wood, any rate is admissible not exceeding 80 feet to the mile in the direction of heaviest traffic and 105 feet to the mile in the other direction."

Again, in 1826, Nicholson, in the "Operative Mechanic and Machinist," sets forth that:

"Some persons have imagined that teethed wheels and rackwork would be necessary when the railway was not perfectly level. But the friction of iron on iron being 25 per cent of the whole weight, if the load was upon the wheels to which the moving power was applied, and if the quantity of power was sufficient, the wagon would ascend without slipping, though the plane rose one foot in four, while even cart roads seldom rise more than one foot in 18 or 20. If four-fifths of the load, however, were placed on separate cars, and only one-tenth of the whole pressure, for instance, was upon the axle to which the moving force was applied, the power of ascent by friction would be only one-tenth of one foot in four, or one foot in forty."

A little later the views must have become modified, for again, in the Ninth Annual Report of the Baltimore & Ohio Railroad Company, in 1835, reference is made to grades of 75 feet to the mile and of 92 feet to the mile. The expectation, however, was to operate these grades as "double (or treble) maximum" grades, by doubling back in order to carry the train over the hill. The reference is as follows:

"We can not recommend that a greater weight than two tons should be allowed to rest upon the rail through one wheel, or that the weight of a locomotive engine upon four wheels should exceed 8 tons; and as the 7½-ton engine appears to be sufficiently powerful for the useful purposes of transit, and would most probably be employed upon all those parts of the line where the use of those of the higher classes will not be needful or expedient; it is possible that heavier engines than those of 7½ tons may be dispensed with upon the higher grades than 25 feet per mile. However, should engines of 6 or 8 wheels be so contrived as to work in curves with the adhesion of all the wheels, or should it be practicable to lay the line of the road so straight in steeper grades, that no difficulty would be experienced in connecting so many wheels, it might then be advantageous to employ engines of 10 or 12 tons weight upon the grade of 92 feet to the mile; and that such engines will yet be made, we confidently anticipate; meanwhile, all the transit can be effected with the 7 or 8 ton engine."

"Upon the western side of this summit, where the grade as contemplated in the preceding pages is to be 75 feet per mile, the 7½-ton engine will not, it is true, convey up at two trips the 87 tons; it would only convey 38 tons per trip, or 76 tons in the two trips. To obviate the evil that would result from this, let the grade be reduced to that of 66 feet per mile, as with some additional expense could readily be done, and then the engine would convey at once 44 tons, and therefore at twice, 87 tons, up the ascent. And here permit us to remark how proper it is in establishing the grades and curvatures of a railway in a hilly or mountain country to consider well the relative efficiency of the motive power upon the several parts of the same. Here, previous to applying the results of calculation, relative to the performance of the engines, we had introduced a grade of 75 feet per mile through a distance of 2 44-100 miles, and by this step it would have required three trips of the engine to convey up the ascent the same load with which it had arrived at the foot of the steeper inclination. Whereas, by lessening the rate of ascent to that of 66 feet per mile, being only 22 feet in the entire

length of the grade, the engine will be enabled to perform the service at only two trips. Very slight modifications, therefore, in the grades or curvatures, may, in the consequent changes in the resistances to be overcome, cause great variations in the cost of transit, and in some cases may even involve a very different arrangement of the motive power."

This arrangement is an alternative method of operation to helper grades, as is well stated by Lardner in his book on the "Steam Engine," in 1840, who says in relation to steep inclines and methods of working them:

"Several expedients have been proposed for this purpose, among which the following may be mentioned:

"(1) Upon arriving at the foot of the plane the load is divided and the engine carries it up in several successive trips."

"(2) A subsidiary or assistant locomotive engine may be kept in constant readiness at the foot of each incline for the purpose of aiding the different trains, as they arrive, in ascending." . . . "This method is at present generally adopted on the Liverpool & Manchester line."

That this system was in use in 1835 appears from the same Ninth Annual Report of the Baltimore & Ohio Railroad, which says:

"Upon the Liverpool & Manchester Railway the locomotive engines used are of three classes, called respectively the train, luggage and 'bank' engines. The train engines weigh about 8 tons, the luggage engines about 9 tons, and the bank engines about 12 tons."

"The information now stated in relation to the engines upon this celebrated road is derived from 'Observations of the Liverpool & Manchester Railway,' by David Stevenson, Edinburgh, read before the Society of Arts for Scotland on the 25th of February, 1835. (See American Railroad Journal, Vol. IV, No. 21, by D. K. Minor.)"

"At the time these facts were collected there were but two bank engines, the 'Goliah' and 'Sampson,' which are used in assisting the trains with passengers and luggage up the inclined planes at Whiston and Sutton; these planes are each 1½ miles in length, and rise 1 in 96, or 55 feet per mile; the residue of the railway traversed by locomotives is either level or inclined 1 in 880, or only 6 feet per mile."

"Economy of arrangement having settled this point, it follows that all grades above 25 feet per mile must necessarily be passed at a loss of useful effect, and at an increased expense of transit. Admitting, therefore, the engines to have their appropriate loads upon the grades of 25 feet per mile and less, and we can not admit the contrary to much extent in the conveyance of commodities, it results, as a consequence, that these loads must be impelled up the grades steeper than 25 feet per mile, either by engines of a higher class, that is, heavier and of more tractile power than those employed upon the leveler parts of the line, or by means of assistant engines in aid of those that shall arrive at the foot of the steeper grade with the trains, or, perhaps, in some cases, by both expedients, or by dividing the train. It is highly important, then, to the cheapness of transit, that the higher grades, if any, should be few and short, and that they should be admitted at as few places as may be practicable, having regard to other important considerations."

With reference to the Liverpool & Manchester Railway it was stated in 1831 by Henry Booth that:

"From the top of the Liverpool tunnel to Manchester, with the exception of two inclined planes at Rainhill (one ascending and the other

descending at an inclination of 1 in 96, and where some assistant power must be used) there is no greater inclination than in the ratio of about 1 in 880."

The principle of equivalent grades for unequal traffic or adjusting grades to the weight of traffic in opposite directions seems to have been recognized at the outset. On the Baltimore & Ohio, in 1828, it was reported by the Engineers of Reconnoisance that:

"For want of more precise data to enable us to compute the relative amounts of transportation, we shall base our estimate upon the probable value of the tonnage in both directions, on the supposition that the state of traffic in any great and permanent channel of commerce will sooner or later be regulated by the relative value of the commodities conveyed to the markets or by the balance in trade."

"Accordingly, we shall suppose that every ton conveyed from Baltimore to Cumberland is of equal value with five tons conveyed in the opposite direction, and that every ton conveyed from Cumberland to the Ohio River is worth two tons in the opposite direction, and that the relative amounts of reciprocal transportation, on the two sections of the road, will conform to these rates of valuation."

"Such being the state of the trade, a system of graduation corresponding thereto now claims our consideration."

"Allusion is here made to such an inclination in the rail-tracks that a given power may be sufficient to propel on the eastern section, in addition to the carriages, five times the amount of tonnage in the direction of the heaviest trade as in that of the lightest trade, and on the western section double the amount of tonnage in the direction of the heaviest trade as in the opposite direction."

"(1) Of the graduation adapted to the state of trade between Baltimore and Cumberland, or the coal region, to be adopted in all cases where the natural surface has an inclination corresponding thereto. The object in view, under this head, is to determine the degree of ascent or acclivity at which the relative amounts of transportation between Baltimore and Cumberland may be attained with equal resistance in both directions. The elements upon which any calculation of this nature must be based are as follows, viz.: The proportion between the outward and return transportation, which we shall assume at the ratio of 1 to 5, which is intended to imply, that for every ton conveyed westward, five tons will be conveyed eastward; the proportion of the weight of a carriage to that of its full load, which we shall assume in the ratio of 1 to 3, implying that a carriage weighing one ton may be made sufficiently strong for the conveyance of a load weighing three tons; and the ratio of the weight or load to the power necessary to propel it, which we shall assume as heretofore stated, at 1 to 150, implying that a traction of one pound is sufficient to propel on a level railroad a load of 150 pounds."

"The result deducible from the foregoing data is, that the inclination of the road will be at the rate of 15.086 feet per mile, or 9.8 minutes of a degree, ascending from Baltimore towards Cumberland."

"(2) Of the graduation adapted to the trade between Cumberland and the Ohio river."

"Assuming the data employed in the preceding calculation, except that the proportion of 1 to 2 is to be substituted, in reference to the relative amounts of transportation, instead of 1 to 5, we arrive at the following results, viz., that the inclination of the road will be at the rate

of 8.12 feet per mile, or 5.29 minutes of a degree ascending towards the Ohio river, or declining towards Cumberland."

"Inasmuch as the natural surface of the ground will not admit of a location in accordance with the results above stated, except in a few instances, we are compelled to resort to a more complicated system of graduation, in order to effect an economical construction of the road by adapting its location to the natural surface in such a manner as to avoid, as much as possible, deep excavations and high embankments, and at the same time render the application of motive power, whether animal or mechanical, more easy, uniform and systematic. For these purposes we shall exhibit, in a tabular arrangement, a series of statements based upon the data assumed agreeably to the views advanced in the preceding articles, and embracing results sufficiently varied for application to all the varieties of graduation likely to occur in the location of the contemplated road."

Quite in the same line is the reference already made to the claim of Thomas Earle in 1830, that

"Any rate is admissible not exceeding 80 feet to the mile in the direction of heaviest traffic, and 105 feet in the other direction."

Similarly, in 1829, Peter Flemming, Chief Engineer, in his Report to the Directors of the Mohawk & Hudson Railway Company, announces that:

"The levels or slopes of the main line of a railway should be adapted to the transport in opposite directions as much as can be obtained from the inequalities of surface;" and "the formation of the slope will always depend upon the weights to be taken in opposite directions."

Something of the principle of Momentum Grades was also known at an early date, as is shown from the following extract from Nicholson's "Operative Mechanic and Machinist," in 1826, which quotes from the "Edinburgh Scotsman:"

"The wagon has acquired an uniform velocity of 20 miles an hour. Then if it is made to ascend an inclined plane of 10 feet perpendicular height, this velocity will be extinguished, and the vehicle stop at the head of the plane. When it is to proceed again on its journey, its descent along an inclined plane of the same height on the other side will enable it to recommence its career in a few seconds with the full velocity of 20 miles an hour. By raised platforms of this kind at the two extremities of the journey and at the intermediate stages, the velocity thus generated might be treasured up for permanent use." "But, in point of fact, the terminal velocity is attained so soon from a state of rest that this contrivance would probably be found unnecessary."

Again, in 1831, Henry Booth, in "An Account of the Liverpool & Manchester Railway," says:

"I am aware that the recent performance of locomotives on an inclined plane has been considered greater than in the ratio I have given; it is very possible that the attained speed and momentum of the engine and carriages, *before commencing* the ascent, have not been taken into account." "Assisted by this momentum the Comet accomplished her

task; her speed, however, diminished from sixteen or eighteen miles to about three or four miles per hour before she reached the top." "The length of inclined planes should be taken into account, as well as the steepness of ascent."

Considerably later, 1846, John B. Jervis very clearly recognized this principle, referring to

"Grades of 10 feet per mile, except at one station 15 feet, but that this was no objection, as all trains would stop there," and, in another place, "momentum will carry them (the trains) over these small ascents."

The principle of "virtual lengths" was also known to the engineers of the Baltimore & Ohio Railroad in 1828, and to William Gibbs McNeill of the Boston & Providence Railroad in 1832, both of whom equated grade for distance in discussing the merits of lines. On the Baltimore & Ohio Railroad it was figured that

"The equated distance corresponding to an elevation of 35.2 feet, whatever may be the angle of inclination, will be equal to the length of any given section of road increased by one mile."

The value of low gradients seems to have been well appreciated upon the very first of our American railroads, but possibly not with a clear idea of their economic value. Just how early changes of gradients were made for the betterment of lines may be uncertain, but it is quite possible that the following citation from the "Prospectus and Report of the Canada Southern" in 1872 may refer to the first important case of that kind:

"No better evidence of the value of low grades can be given than that which is exemplified by the experienced managers of the Pennsylvania Railroad Company, who are now engaged in founding a low grade line for freight by which they will abandon 250 miles of their present main line for through traffic, although it will increase the length of line to be run 62 miles and involve the actual construction of 110 miles of a new and expensive road."

There is no question as to the fact that within the past few years the principal railroads in the United States and Canada have been revising and improving their lines on a large scale, and in many cases disusing long stretches of line as originally located and constructed.

In the early days of the present generation of engineers, Wellington, in his "Economic Theory of Railway Location" treated this general subject in a full and logical manner. His work is so well known that comments upon it here are unnecessary. His acknowledgment of the ability shown by the early engineers, despite conditions in general as then existing, is admirably given in the dedicatory notice in his work:

"To the great men of a former generation, who originated the American Railway System, this attempt to improve upon their practice is admiringly inscribed, in token of respect for their far-sighted sagacity and still unequaled skill."

SPECIFICATIONS FOR CONSTRUCTION OF ROADWAY.

IN GENERAL.

Alinement

1. The center of the roadbed shall conform in alinement to the center stakes.

Subgrade.

2. The grade-line on the profile denotes subgrade, and this term indicates the tops of embankments or bottoms of cuttings ready to receive the ballast.

Cross-sect

3. The roadbed shall be formed to the section, slopes and dimensions shown upon the standard drawings, or to such modifications thereof as are required to meet special conditions, as may be from time to time directed.

Width of Roadbed.

4. When finished and properly settled, the roadbed shall conform to the finishing stakes, and shall be of the following dimensions at subgrade for single track, viz.:

On embankments, twenty (20) feet wide, and in excavations, twenty (20) feet, exclusive of the width necessary for ditches. For each additional track an additional width of fourteen (14) feet shall be made.

Slopes.

5. The slopes of earth embankments shall be at an inclination of one and one-half to one; embankments of rock, from one to one, to one and one-half to one; earth or common excavations, one and one-half to one; solid rock excavations, from one-quarter to one, to one-half to one; loose rock excavations, from one-half to one, to one to one. All slopes are expressed in the ratio of the horizontal distance to the vertical rise.

Special Slopes.

6. These ratios may be varied by the engineer, according to circumstances, and the slopes shall be made as directed in each particular case.

CLEARING.

Extent of Clearing.

7. The whole of the land comprising the right of way and station grounds, except any portions thereof that may be reserved, shall be cleared of all trees, brush and perishable materials of whatever nature.

Disposal Brush, et

8. All these materials, with the exception of such as are hereafter mentioned, shall be burned or otherwise removed from the ground, as may be directed, and without injury to adjoining property.

Stumps.

9. Where clearing is to be done, stumps shall be cut off even with the ground, except between the slope stakes of embankments, where stumps may be cut so that the depth of filling over them will not be less than two and one-half (2½) feet.

Clearing Advance.

10. The work of clearing shall be kept at least one thousand (1,000) feet in advance of grading.

Cutting a Piling W

11. All trees which may be reserved shall be stripped of their tops and branches, made into ties, or cut to such lengths as may be directed,

and neatly piled at such places on the right of way as may be designated, for which service payment will be made by the tie, or by the cord of one hundred and twenty-eight (128) cubic feet.

Fences, Buildings, etc.

12. Fences and other movable property on the right of way shall be carefully removed or piled up, as may be directed, without extra charge, it being understood that the price for clearing covers these items. In localities where buildings exist, payment will be made for their removal at a price to be agreed upon.

Measurement.

13. Measurement of clearing and payment for the same will be by the square of one hundred (100) feet square, or fraction thereof, actually cleared.

Isolated Trees.

14. In the case of isolated trees, the area to be computed and paid for as clearing shall be that covered by the overhang of the branches.

Annual Growths.

15. No allowance will be made for burning, or otherwise removing as may be directed, grain, grass or other annual growths, it being understood that the contract price for grading covers this item.

GRUBBING.

Extent.

16. Stumps must be grubbed entirely from all places where excavations occur, including ground from which material is to be borrowed, as well as from ditches, new channels for waterways and other places where required.

Grubbing will also be required between the slope stakes of all embankments of less than two and one-half feet in height.

Grubbing in Advance.

17. The work of grubbing shall be kept at least three hundred (300) feet in advance of grading.

Measurement.

18. Measurement of grubbing executed as directed shall be estimated upon all excavations, and the space to be covered by an embankment of two and one-half (2½) feet in height or less. Payment for the same will be by the square of one hundred (100) feet square or fraction thereof actually grubbed.

GRADING.

Work Included.

19. The term, "Grading," in these specifications includes all excavations and embankments for the formation of the roadbed, ditching, diversions of roads and streams, foundation pits, and all similar works connected with or appertaining to the construction of the railway, its side tracks, spur tracks and station grounds.

Classification.

20. All material excavated shall be classified as "Solid Rock," "Loose Rock" or "Common Excavation."

Solid Rock.

21. *Solid Rock* shall comprise rock in solid beds or masses in its original position, which, in the judgment of the engineer, may be best

removed by blasting, and boulders or detached rock, measuring one cubic yard or over.

Loose Rock.

22. *Loose Rock* shall comprise all detached masses of rock or stone of more than one cubic foot and less than one cubic yard, and all other rock, which, in the judgment of the engineer, can be properly removed by pick and bar and without blasting, or which can be removed by steam shovel (although blasting may be resorted to on favorable occasions in order to facilitate the work).

Common Excavation.

23. *Common Excavation* shall comprise all other materials of whatever nature that do not come under the classification of solid rock or loose rock or such other classifications as may be established before the award of contract.

Finishing Slopes.

24. Slopes of all excavations shall be cut as true and straight as may be practicable, and all loose stones in the slopes must be removed.

Excavation Below Subgrade.

25. Rock excavations must in all cases be taken out nine (9) inches below subgrade, and refilled to subgrade with approved material.

Excess Excavation and Slips.

26. Excavation in excess of the authorized cross-section, as well as slides extending beyond the slope lines, shall not be paid for, unless such are due to causes which are not under the control of the contractor or his agents. In all cases, the surplus material shall be removed by the contractor without delay, and the slopes formed to the satisfaction of the engineer. The classification of the material shall be in accordance with its condition at the time of removal, regardless of prior conditions.

Disposal of Excess Excavation.

27. Where the quantity of excavation exceeds that required to make the embankments to standard cross-section, the surplus shall be used to widen the embankments uniformly, along one or both sides, as may be directed, and no material shall be deposited in waste banks unless such waste be indicated either on the profiles or by written order of the engineer.

Waste Banks.

28. Where wasting is ordered, the material shall, if possible, be deposited below grade line, and under no circumstances shall the waste bank have its nearest edge within twenty-five (25) feet of the slope stakes of the cutting.

Borrow, etc.

29. Where the quantity of excavation from the cuttings of standard cross-section is insufficient to form the embankments, the deficiency shall be made up by widening the cuttings on one or both sides of the center line, as may be directed, and no material shall be taken from borrow pits, unless such borrow be indicated either on the profiles, or by written order of the engineer.

Approximate Quantities Shown.

30. The classification and quantities shown on the profile exhibited for distribution of material are approximate only, and will in no way govern the final estimate. The company reserves the right to increase

or diminish the quantities given, without affecting the contract unit prices for the various parts of the work.

Reserving Gravel, etc.

31. Where gravel, stone or any other material suitable for special uses of the company is met with in the excavations, the same shall, when required, be reserved and deposited in convenient places on the right of way, as directed, and other suitable material in the vicinity substituted as required to complete the embankments.

Berme in Rock Cuttings.

32. A berme of four (4) feet shall be left between the top of slope of rock cuttings and toe of slope of overlying earth.

Intercepting Ditches.

33. Intercepting ditches shall be made at the top of the slopes of all cuttings where the ground falls toward the top of the slopes, and they must diverge sufficiently to prevent erosion of the adjoining embankment. The cross-section and location of such ditches will be designated, and, if required, shall be made in advance of opening the cutting.

Ditches in Cuttings.

34. Ditches shall be formed at the bottom of the slopes in cuttings according to the cross-section shown upon the plans, or such modifications thereof as may be directed; they shall be neatly made, clear of obstructions, and at the lower end must diverge sufficiently to prevent erosion of the adjoining embankment.

Subdrains.

35. Where subdrains of tile are necessary, the size and location of such will be determined by the engineer. Trenches for these drains must be taken out at least twelve (12) inches below frost line, the tiles shall be laid on a bed of at least twelve (12) inches of cinders, or other suitable porous material, with a filling of at least twelve (12) inches of the same material on either side of and above the tile, and then covered with ordinary soil to the top of the trench.

Measurement and payment for such drains will be by the lineal foot, according to diameter of tile, including excavation and refilling; the contractor to furnish all material for the same.

Unsuitable Material.

36. Excavations incident to the construction of the roadbed, ditches, channels and roadways shall be used in forming the embankments; but no unsuitable material will be allowed to enter into their composition.

Formation in Layers.

37. Wherever it is practicable, embankments shall be built in horizontal layers of from two (2) to four (4) feet in thickness; these layers to be of the full width of the embankment, and built to the true slope, and not widened with loose material from the top. The most suitable material must in all cases be reserved for finishing the surface, and no large stones will be allowed within a depth of at least two (2) feet below subgrade.

Shrinkage, etc.

38. Embankments shall be carried to such height above subgrade or to such increased width as the engineer may deem a necessary provision for shrinkage, compression and washing. As the embankments become consolidated, their sides shall be carefully trimmed to the proper slopes, and they must be maintained to their proper height, dimensions and shape until the work is finally accepted.

Embankments on Slopes, etc.

39. When an embankment is to be placed on sloping ground, the surface shall be deeply plowed or stepped; and whenever directed, boggy or unsuitable material shall be excavated so that the embankment shall be started from a firm foundation.

Embankments across Swamps.

40. In crossing bogs or swamps of unsound bottom, the engineer may require a special substructure of logs and brushwood, the logs forming this foundation to be not less than six (6) inches in diameter at the small end. If necessary there shall be two or more layers crossing each other at right angles, the logs of each layer being placed close together, with broken joints and covered closely with brush; the bottom layer shall be placed transversely to the roadway and project at least five (5) feet beyond the slope stakes of the embankment.

Measurement of this substructure and payment for the same will be by the square of one hundred (100) feet square, or fraction thereof, of area covered by each layer.

Filling Trestles.

41. In forming embankments to take the place of existing trestles, the material must be thoroughly compacted between the trestle bents and around and under all parts of the structure, and in case of train filling by means of a temporary trestle, the material must be uniformly spread in the fill.

Embankments at Trestles.

42. Embankments abutting against the ends of trestle bridges shall be brought forward upon the structures a distance of at least six (6) feet, with an increased breadth of two (2) feet, in order to form a full roadbed.

Finishing Subgrade.

43. The subgrade must be compact, and finished to a true plane, and no depressions left that would hold water.

Embankments over Masonry, etc.

44. In embankments over or about masonry or other structures, the material shall be deposited in thin layers, and each layer carefully tamped. Special care must be exercised not to unduly strain these structures, and only the best material available will be allowed for the purpose of such filling. The contract price for excavation shall cover the cost of obtaining, distributing and packing the material behind, over and around all such structures.

BORROW PITS.

Land Provided.

45. Land for borrow pits or waste banks will be provided by the railroad company.

Drainage.

46. Borrow pits within the limits of the right of way shall be regular in width, and, if necessary, connected with ditches, and drained to the nearest water course. Unless directed, material shall not be borrowed to a depth that will not permit of proper drainage.

Slopes and Bermes.

47. Side slopes of borrow pits on the right of way shall be of similar angle to the prism of the road. A berme of not less than eight (8) feet in width shall be left between slope stakes of the embankment and the edge of the borrow pit, and a berme of not less than three (3) feet between the

outside slope of the borrow pit and the right of way line. Bermes must consist of the original unbroken ground.

Regularity of Pits.

48. Borrowing must be done in regular shape in order to admit of ready and accurate measurement.

Cross-sectioning of Pits.

49. Borrow pits shall not be excavated before they have been staked out and cross-sectioned.

Exceptions in Borrow and Waste.

50. In land set apart for station grounds, or other special purposes, no borrowing nor wasting of material will be allowed, except by written directions of the engineer.

PRICE AND MEASUREMENT OF GRADING.

Basis.

51. All grading will be estimated and paid for by the cubic yard, at the prices specified for the respective materials. Measurement shall be made in excavation only, except in cases hereinafter mentioned.

Work Included in Price..

52. The contract prices per cubic yard will include the excavation of the material by any method whatever, the loading, transportation and the deposit of the same in the manner described by this specification, and in the places designated, the plowing or benching of slopes, as well as all other expense incident to the work of grading.

Haul.

53. Unless otherwise specified the contract prices per cubic yard cover any haul found necessary, and there will be no allowance made for any so-termed "overhaul."

Embankment Measurement

54. If it be impracticable to measure borrowed material in excavation, it may be measured in embankment, using the cross-section notes of the embankment prisms, and making a just and reasonable allowance for change in bulk, so that the quantities shall equal the excavation quantities as nearly as possible.

Borrow Classification.

55. There shall be no classification or allowance made for loose or solid rock in borrow pits, unless specific written instructions are given to the contrary, it being the intent and meaning of this specification that all borrowed material shall be classified and paid for as common excavation.

TUNNEL EXCAVATION.

Line, Grade and Cross-section.

56. Tunnels shall be excavated to the alinement and gradients shown upon the plans, or to such modifications thereof as may be directed, and they shall conform as nearly as practicable with the standard cross-section, as shown upon drawing No. .....

Lined Tunnels.

57. Tunnels which require lining with masonry or timber shall be excavated to the cross-section shown upon drawing No. .....

Bottom of Rock Tunnels.

58. In rock tunnels the material must in all cases be taken out nine (9) inches below subgrade, and refilled to subgrade with approved material.

Blasting.

59. Blasting must be done with all possible care, so as not to damage the roof and sides, and all insecure pieces of rock beyond the standard cross-section shall be removed by the contractor.

Excess Excavation.

60. Excavation in excess of the authorized cross-section will not be paid for. If the drilling or use of explosives is improperly managed, and unnecessarily shatters the sides, roof or lining of the tunnel, the engineer will have the right to regulate the drilling and use of such explosives.

Price to Include.

61. The price paid for tunnel excavation shall embrace the cost of removal of all materials between the outer faces of the two (2) portals, and shall include the loosening, loading, transportation and placing of the material in embankment or waste banks, as directed; it shall also include whatever materials and labor are required for temporary props, supports and scaffolding for the safe prosecution of the work, as well as all expense of keeping the tunnel ventilated and free from water, oil or gas.

Niches or Recesses.

62. Niches or recesses for the protection and convenience of the railway employés shall be provided at designated intervals.

Shafts.

63. The engineer will determine the location, number and dimensions of all shafts, and the excavation price for them shall cover all materials contained within the specified cross-sections, between the surface of the ground and the connection of the shafts with the tunnel; said price will also cover whatever materials and labor may be required for curbing or such other support as the sides of the shaft may require, the cost of keeping the shafts free of water or oil, as well as the cost of all pumping and hoisting machinery.

Wells or Sumps.

64. All wells or sumps within the tunnel necessary for its permanent drainage, and made as directed, shall be paid for at the same rate per cubic yard as for tunnel excavation.

Right of Way for Roads.

65. The contractor will make all arrangements, and be at the sole expense, of any right of way necessary over the top of the tunnel for such roads between the ends of the tunnel as he may need, and all grading necessary for the same will be done at his expense.

Haul.

66. It is distinctly understood that the contract prices per cubic yard for tunnel and shaft excavation, respectively, cover any haul found necessary in placing the material where designated, and that there will be no allowance for any so-termed "overhaul," unless otherwise specified in the contract.

CLAUSES SPECIALLY APPLICABLE TO REVISION OF EXISTING LINE, OR WIDENING FOR AN ADDITIONAL TRACK.

Delay to Train Service.

67. The contractor must so regulate his methods of work as not to interfere in any manner with the train service of the company, and he will be responsible for any damage to the company's property caused by his acts or those of his employés. It is estimated and agreed that a

proper basis of damages for train delays shall be at the rate of one dollar for each minute of delay of each train delayed, and said amount shall be payable by the contractor, and deducted from his estimate. And, if continuous detention occur to the train service, the company reserves the right to complete the work on summary notice to the contractor in writing, and at expense of said contractor.

Precautions for Safety of Trains.

68. No heavy blasting will be allowed close to the main tracks, nor will the contractor be permitted to transport material under any circumstances along or between the company's tracks. Wherever the work is liable to affect the safety of trains, the method of doing such work must first be submitted to the engineer for his approval, and without his approval no such work shall be commenced or prosecuted.

When and How Company's Tracks May Be Moved.

69. Under no circumstances shall the contractor move or in any way interfere with the company's tracks. Whenever during the progress of the work it becomes necessary that the main line or side tracks be moved, it shall be done by the company, and the actual cost thereof charged to the contractor and deducted from his estimate.

Precautions for Safety of Tracks.

70. Whenever the work as authorized affects the safety of the tracks, the company shall take such precautions as it may deem advisable to ensure the safety of such tracks, and the cost of so doing shall be charged to the contractor and deducted from his estimate.

Location of Additional Track.

71. The location of the additional track will be on the..... side of existing line, but whenever it is expedient to change any portion to the ..... side, the altered alinement will be shown upon the maps or diagrams furnished by the company, and the contractor shall confo-m to the same without extra charge.

Plowing Slopes.

72. Whenever the existing embankments of four (4) feet in height or over are raised or widened, the slope of the existing embankment shall be deeply plowed in order to bind the new material thoroughly to it.

Crossings.

73. Wherever it is necessary for material of any description to be transported across the existing track or tracks, the location of the crossings must be approved by the engineer, and the contractor shall furnish at his own cost the lumber and spikes for said crossings. The labor of placing the same will be done by the company, and the actual cost charged to the contractor, and deducted from his estimate.

Watchmen.

74. Watchmen, both day and night. will be put on by the company at all places the engineer considers necessary for the safety of the company's trains and works, and the cost shall be charged to the contractor and deducted from his estimate. It is distinctly understood, however, that the providing of such watchmen shall not relieve the contractor from the liability and payment for damages caused by his operations.

Safety Signals.

75. The cost of all signals necessary to ensure the safety of trains, consequent upon the contractor's work, shall be borne by the contractor, and all instructions regarding their observance shall be strictly obeyed by him.

GENERAL CONDITIONS.

Temporary Fences.

76. Previous to or during the work of grading, the contractor, if required, shall erect and maintain temporary fences, in order to prevent trespass upon the railway or damage to adjoining property.

Crossings, Damage to Property, etc.

77. He shall make and keep in good condition, commodious passing places for public and private roads traversed by the line of railway, and shall be held responsible for damages of whatsoever nature, to persons or neighboring property, caused by workmen in his employ leaving gates or fences open, blasting rocks, building fires, or in other ways, and, if necessary, payment of the engineer's estimate may be withheld until such damages are satisfactorily settled for, the intention of the contract being that the company shall not be held responsible for any claims or losses incurred during the construction of the line, due to the operations of the contractor.

Changes of Alinement or Gradients, etc

78. The alinement, gradients and cross-sections of the road, as well as ditches and other incidental work, may be altered in part or in whole as deemed necessary, either before or after the commencement of the work, but any such change or alteration shall not affect the unit prices specified in the contract. Nor shall any such change or alteration constitute a claim for damages, nor shall any claim be made or allowed on account of such change or alteration, except that if the Chief Engineer shall deem the change or alteration to have materially increased the rate of cost of doing the work, he shall fix a price over and above the specified unit price, to be paid to the contractor on account of such increase in cost occasioned by such change or alteration.

Work to be Paid for as Extra.

79. The contractor shall be paid only for work actually done, at contract rates, excepting in cases of cuttings or embankments where the slopes have actually been completed and accepted; when such slopes are required to be altered, the contractor shall be paid for the actual labor of re-sloping at the current rate of wages, plus ten (10) per cent.

Snow and Ice.

80. Before beginning grading, as well as during the progress of the work, the contractor must remove all snow and ice from between the slope stakes, and at his own expense.

Bench Marks and Stakes.

81. The contractor shall carefully preserve all bench marks and stakes given by the engineer, and in case of neglect to do so, will be charged with the resulting expense.

Roads.

82. Whenever required by the engineer, the contractor must open up a safe road for passage on horseback and foot along the whole or any portions of the work under contract.

Temporary Roads, Trestles, etc.

83. No allowance or compensation whatever shall be due or paid to the contractor for any temporary roads, bridges or trestles he may make to facilitate the work.

Final Clearing Up.

84. Before the work is finally accepted, the contractor must, at his own expense, clear away from the company's property, as well as from public and private roads, and the channels of streams and ditches, all rubbish and surplus blasted or excavated material.

Extra Work.

85. The cost of any extra work will not be considered or allowed, unless such extra work shall have been done by direction in writing of the engineer, and such written directions must in every case contain the rates and methods of payment for said extra work.

Contractor's Risk.

86. The contractor shall take all risks from casualties of every nature, and will not be entitled to any compensation for detentions from such causes.

Company Defined.

87. Whenever the word "company" is used in these specifications it designates the ..... company.

Contractor Defined.

88. The word "contractor" is used herein to designate the person or persons undertaking the work referred to in these specifications and drawings.

Engineer Defined.

89. Whenever the word "engineer" is used, it designates the engineer of the railway company who is in immediate charge of the work, and whose directions as to the performance of the work shall be obeyed, but the directions of any subordinate engineer, in writing or otherwise, shall also be obeyed by the contractor, when said subordinate engineer is acting within his regular duties, or is directly transmitting the orders of his superior.

Chief Engineer Defined.

90. Whenever the words "Chief Engineer" are used, they designate the Chief Engineer for the time being of the railway company.

*91. In the foregoing specifications, it is understood that it is the engineer or chief engineer whose judgment, direction, decision, approval, etc., are referred to, whenever such terms are used.

Specifications Part of Contract.

92. The specifications and general conditions, together with the drawings referred to, are distinctly understood as being embodied with the contract, the whole forming the entire agreement between the company and the contractor.

*See amendments, page 688.

DEFINITIONS OF TERMS USED IN THE FOREGOING SPECIFICATIONS.

ALINEMENT.—The ground plan of the center line of a track in distinction from its gradients or profile.

ELEVATION OR HEIGHT.—The distance of any given point above an established plane.

GRADE-LINE.—The line on the profile representing the tops of embankments and bottoms of cuttings ready to receive the ballast.

GRADIENT.—The rate of ascent or descent of the center line.

PROFILE.—The intersection of a longitudinal vertical plane with the ground or established gradients; or a drawing representing the same.

RIGHT-OF-WAY.—The land or water rights necessary for the roadbed and its accessories.

ROADBED.—The surface upon which a track is laid.

CUT OR CUTTING.—The space formed by excavating along the line of roadbed through any material, to reach an established grade.

EMBANKMENT OR FILL.—A bank of earth, rock or other material constructed for the purpose of carrying a track above the natural ground surface.

SUBGRADE.—The tops of embankments and bottoms of cuttings, ready to receive the ballast.

BERME.—An approximately horizontal surface between the top or toe of a slope and a boundary line, ditch or other excavation, for the protection of the slope.

BORROW PIT.—A pit dug for obtaining material for making an embankment or other filling.

BORROW (noun).—The material for filling obtained elsewhere than from the prisms of the regular cuttings.

CONSTRUCTION.—The act of building or making.

EXCAVATION.—The artificial cutting down of the natural ground surface. The material taken from cuttings, borrow pits or foundation pits. The space formed by excavating.

GRADE (verb).—To prepare the ground for the reception of the ballast and track, and other similar works appertaining thereto.

GRADING.—The work of excavation or forming of embankment for the roadbed.

CLEARING.—The removal of timber and other material from the surface of the ground.

GRUBBING.—Removal by the roots.

HAUL.—The distance within a given limit that material is hauled in constructing the roadbed.

OVERHAUL.—The distance beyond a given limit that material is hauled in constructing the roadbed.

TUNNEL.—A passageway under ground or water.

CROSS-SECTION.—A section through any material or structure perpendicular to the axis.

SLOPE.—The inclined face of a cutting or embankment.

CONTOUR.—The horizontal outline of a figure or surface.

DITCH.—An open artificial waterway for providing drainage.

DRAIN.—A closed artificial waterway for conducting water from the roadway.

SUBDRAIN.—A covered drain below the roadbed or ground surface.

TRENCH.—A ditch for providing drainage.

DRAINAGE.—The removal or interception of water from above or under the roadway.

EROSION.—The wearing away of material.

BOG.—Wet spongy ground of decayed and decaying vegetable matter.

ROCK.—A large, hard mass of mineral substance.

SPECIFICATIONS.—A written or printed statement containing an enumeration of particulars.

STANDARD.—That which is established as a guide or model.

SETTLEMENT.—Sinking; an adjustment in the direction of permanent position.

STABILITY.—Permanence; firmness; resistance to displacement.

TEMPORARY.—Constructed for a short term of service.

CONCLUSIONS.

In regard to Specifications for Construction of Roadway, the undermentioned recommendations are respectfully submitted for adoption by the Association:

(1) Similarity in general form.

*(2) A threefold classification of materials, viz.: Solid Rock, Loose Rock and Common Excavation, as herein described.

(3) That information on profiles, as to distribution of material, be so arranged that price for grading for each of the classes may cover the haul, irrespective of distance.

(4) That the foregoing form represents the best principles of theory and practice.

(5) The definitions of terms as given.

Respectfully submitted,

W. McNab, Assistant Engineer, Grand Trunk Railway System, Montreal, Can., *Chairman;*

H. J. Slifer, General Superintendent, Chicago, Rock Island & Pacific Railway, Chicago, Ill., *Vice-Chairman;*

C. Frank Allen, Professor of Railroad Engineering, Massachusetts Institute of Technology, Boston, Mass.;

H. Baldwin, Superintendent, Cleveland, Cincinnati, Chicago & St. Louis Railway, Mattoon, Ill.;

R. C. Barnard, Superintendent, Cleveland, Akron & Columbus Railway, Akron, O.;

J. B. Berry, Chief Engineer, Union Pacific Railroad, Omaha, Neb.;

A. C. Dennis, Civil Engineer, Clarksburg, W. Va.;

C. Dougherty, Superintendent, Illinois Central Railroad, Clinton, Ill.;

W. D. Pence, Professor of Civil Engineering, Purdue University, Lafayette, Ind.;

H. C. Phillips, Engineer, Western Grand Division, Atchison, Topeka & Santa Fé Railway, La Junta, Colo.;

W. F. Tye, Assistant Chief Engineer, Canadian Pacific Railway, Montreal Can. *Committee.*

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*See amendments, page 688.

AMENDMENTS.

91. In the foregoing specifications it is understood that it is the Engineer or Chief Engineer whose judgment, direction, decision, approval, etc., are to be accepted, whether such terms are actually used or not.

CONCLUSION No. 2.—A threefold classification of materials, viz., Solid Rock, Loose Rock and Common Excavation, as herein described, and in special cases such additional classification of material as may seem necessary; such additional class to be distinctly defined and specified in the contract.

APPENDIX.

REDUCTION OF GRADIENT, AND ELIMINATION OF DISTANCE, CURVATURE, AND RISE AND FALL ON UNION PACIFIC RAILROAD.

By J. B. Berry, Chief Engineer, Union Pacific Railroad.*

When the present owners of the Union Pacific Railroad took possession of the property January 1st, 1898, it was decided that extensive improvements should be made in order to put the road in condition for more economical operation. After a thorough examination of the conditions a general policy was agreed upon which has since been carried out, and for which the management has made liberal appropriations. The proposed improvements included increase in size of locomotives and capacity of cars, reduction of ruling gradients and elimination of as much distance, curvature and rise and fall as was practicable. These improvements were to extend over all the main lines, but owing to the peculiar conditions existing on the Wyoming Division, Cheyenne to Ogden, a distance of 516 miles, the most radical changes were to be made there.

A careful study was made of the maps and profiles of the constructed line and the records of earlier surveys and explorations in the territory under consideration, and engineers were placed in the field to re-run some of the old lines and make additional surveys. It was decided that by doing some very heavy work, a ruling gradient of 0.82 per cent., or 43.3 feet per mile, could be established on the Wyoming Division, with the exception of the two places hereafter mentioned. The reduction of ruling gradients was considered the most important object to be attained in the relocation of the line, saving in distance next, reduction of total degrees of curvature third, and saving in rise and fall fourth.

In addition to the more important work of reducing maximum grades, lowering main summits and avoiding the wide detours made by the old line, much attention was devoted to minor changes which would take out curvature or other features unfavorable to a high speed line.

It was found that at two places on the division it would be impossible to reduce the gradient to the adopted maximum and that helper grades would have to be retained, but that these could be materially improved. These places are: Cheyenne to Buford, a distance of 27 miles westbound, and Ogden to Wahsatch, 65 miles eastbound, the latter stretch lying mostly in Weber and Echo Canons and having grades varying from 53 to 96 feet per mile. On this section the grades and alinement were, how-

* The author wishes to acknowledge his thanks for the assistance given him in the preparation of the matter presented in this Bulletin by Messrs. Shurtleff and Cone, of the Engineering Department, Union Pacific Railroad, and also by Mr. W. P. Watson, who was at one time an employe of this department.

ever, susceptible of considerable improvement. Between Buford and Wahsatch, a distance of 424 miles, it was found practicable to make the revisions necessary to obtain the proposed ruling gradient of 43.3 feet per mile in each direction.

In the Chief Engineer's office estimates were made of the various locations, and statements prepared showing comparisons of physical characteristics, and of the estimated annual saving in operation of the proposed lines as compared with the existing line. These comparative estimates were made in accordance with the method given by Mr. A. M. Wellington, using his classification of expenses and percentages affected by changes in gradients, distance, etc., but applied to the actual cost of operation on the Union Pacific Railroad for a period of years.

The following summary, Table A, will give an approximate idea of what has been actually accomplished up to the termination of the fiscal year ending June 30, 1902, on the first four engine districts of the division. The operating statistics, Table B, are deduced from reports made by the Auditor. "Before Change" shows the average for the two years ending June 30th, 1900, and "After Change" for the year ending June 30th, 1902.

The reductions in gradient, distance, etc., given in Table A are for the more important changes in the line; minor changes in line made in connection with revision of grade work would increase these savings somewhat. On the district west of Evanston much improvement work has been done, especially in the canon between Wahsatch and Ogden. Here a great deal of bad and dangerous curvature has been eliminated and re-

TABLE A.

A Comparative Summary of Physical Characteristics, Union Pacific Railroad.

Cheyenne to Evanston, Wyoming, Before and After Revision.

	Cheyenne to Laramie.	Laramie to Rawlins.	Rawlins to Green River.	Green River to Evanston.	Total.
Length of District in Miles—					
Before Change	56.53	136.44	135.63	110.29	438.89
After Change	56.90	116.99	134.16	100.08	408.13
Miles of New Line built in making change	29.63	59.12	43.84	34.73	167.32
Maximum Gradient, Compensated, feet per mile—					
Eastbound, Before Change	97.7	58.0	70.2	67.0	
After Change	43.3	43.3	43.3	43.3	
Westbound, Before Change	88.0	75.3	67.6	68.6	
After Change	82.0	43.3	43.3	43.3	
Increase in Total Curvature, degrees	86				
Decrease in Total Curvature, degrees	...	4668	739	1847	7168
Decrease in Rise and Fall, feet	162	128	77	265	632

TABLE B.

A Comparative Summary of Operating Statistics, Union Pacific Railroad.
Cheyenne to Evanston, Wyoming, Before and After Revision.

	Cheyenne to Laramie.	Laramie to Rawlins.	Rawlins. to Green River.	Green River to Evanston.
Average Number of Daily Trains each way:				
Before Change, Freight	6.66	6.57	6.17	4.50
Passenger	3.00	3.00	3.00	3.00
After Change, Freight	7.52	7.12	6.19	4.44
Passenger	4.00	4.00	4.00	4.00
Helper Engine Mileage in actual assistance of trains per 1,000 freight train miles:				
Before Change	369	246	290	344
After Change	180	3*	2*	35*
Passenger Helper Engine Mileage per 1,000 passenger train miles for entire Division:				
Before change	163			
After change	21			

* Helper Engine Mileage does not include return of light engine The small amount of helper mileage "after change" on districts from Laramie to Green River is not due to helper grades. On district Green River to Evanston, the Aspen Tunnel line was not thrown open to operation until October, 1901, when helper service was discontinued.

vision of grade work prosecuted with a view to ultimately having a more uniform grade and better line.

It will be noted that on each district, except Cheyenne to Laramie, there has been a saving in distance and curvature as well as a reduction of gradient. On this district, which crosses the Rocky Mountains, with an increase in distance of only 0.37 miles and 86 degrees additional curvature, the summit was lowered 236 feet, the eastbound grade reduced to the adopted maximum, the westbound helper grade shortened about 6 miles, and reduced from 88 to 82 feet per mile.

The increase in the number of trains is due to increase in volume of traffic. The average weight of train behind engine and tender has been greatly increased, owing partly to reduction of grade and partly to the introduction of more powerful locomotives and larger cars.

It may appear to those unfamiliar with the character of the country that the great saving in distance and reduction of grade would stand as a criticism of the work of the pioneer engineers who made the original location of the railroad. Such is not the case. The changes made have been expensive and could be warranted only by the volume of traffic handled at the present day. Too much credit can not be given Gen. G. M. Dodge and his assistants. They studied their task thoroughly and performed it well. Limited by law to a maximum gradient of 116 feet to the mile, not compensated for curvature, they held it down to about 90 feet per mile.

Taking into consideration the existing conditions 35 years ago: lack of maps of the country, hostility of the Indians, which made United States troops necessary for protection of surveying parties, difficult transportation, excessive cost of labor, uncertainty as to probable volume of traffic, limited amount of money and necessity to get road built soon as possible, it can be said, with all our present knowledge of the topography of the country, that the line was located with very great skill.

ECONOMIC BASIS OF REVISION WORK.

In order to intelligently locate a line for a railroad, it is essential that a study be made to determine what effect the location and construction cost of different routes would have on the operating expenses and fixed charges of the road. Any expenditure in construction which reduces operating expenses by an amount greater than the interest charges on such expenditure will be an economy. The volume of traffic being equal, the most economical location is that which will require the least expenditure to cover the combined cost of interest and operating expenses.

The details of location affecting operating expenses are *Gradients, Distance, Curvature* and *Rise and Fall.* As the effect of these details on operating expenses varies most directly with the number of trains operated, the "train mile" is used as the general operating unit.

In order to determine the relative merits of different locations, values must be ascertained for each detail affecting operating expenses. "The Economic Theory of Railway Location," by Mr. A. M. Wellington, treats the entire subject fully. In this work Mr. Wellington has given to engineers a logical method of obtaining the values for distance, curvature, rise and fall and gradients, but the modern classification of operating expenses as adopted by the Interstate Commerce Commission gives these expenses in greater detail than could be obtained during the life of Mr. Wellington. This detail is of material assistance in following out Mr. Wellington's general method, as it lessens the chance for error in judgment as to the proportion of each item of expense which will be affected by changes in the details of location.

Prof. W. L. Webb, in his recent work on "Railroad Construction," has developed values for the various details, following the general method given by Mr. Wellington, but using the classification and figures given in the Reports of the Interstate Commerce Commission for the entire railway system of the United States. A study of these reports shows that the average cost per train mile in the more populous states is less than in the states west of the Missouri River.

In order to obtain a value of these details of location for the use of engineers in the Western states, the general methods of both Mr. Wellington and Prof. Webb are applied in this paper to the operating expenses of the Union Pacific Railroad Company.

Table No. 1 is deduced from statements of operating expenses for the four years ending June 30th, 1902, and shows the percentage that each item of the table bears to the whole. The average cost per train mile is

TABLE No. 1.

Statement showing the average proportion that each item of OPERATING EXPENSES bears to the whole on Union Pacific Railroad for the four years ending June 30th, 1902.

Item No.	ITEM.	Per Cent. of Whole.
	Maintenance of Way and Structures:	
1	Ballast	0.28
2	Frogs and Switches	0.35
3	Protection of River Banks	0.03
4	Repairs of Roadbed and Track	8.33
5	Repairs of Snow Fences and Sheds	0.10
6	Spikes and Rail Fastenings	0.86
7	Superintendence	0.55
8	Renewals of Rails	2.28
9	Renewals of Ties	3.01
10	Repairs and Renewals, Bridges and Culverts	1.81
11	" " " Road Crossings, Signs, Cattle Guards, etc	0.32
12	" " " Buildings and Fixtures	1.99
13	" " " Telegraph	0.15
14	Stationery and Printing	0.01
		20.07
	Maintenance of Equipment:	
15	Superintendence	0.63
16	Repairs and Renewals, Locomotives	10.19
17	" " " Passenger and Sleeping Cars	2.07
18	" " " Freight Cars	5.32
19	" " " Work Cars	0.51
20	" " " Shop Machinery and Tools	1.03
21	Stationery, Printing and Other Expenses	0.80
		20.55
	Conducting Transportation:	
22	Superintendence	1.50
23	Engine and Round-house Men	10.10
24	Fuel for Locomotives	10.80
25	Water, Oil, Waste and Other Supplies for Locomotives	1.36
26	Train Service	5.55
27	Train Supplies and Expenses	1.91
28	Switchmen, Flagmen, Watchmen and Switching Charges	2.36
29	Telegraph Expenses	2.44
30	Station Service and Supplies	5.62
31	Car Mileage	0.61
32	Hire of Equipment	0.04
33	Loss and Damage to Freight, Property, Stock; Injury to Persons and Clearing Wrecks	1.88
34	Advertising, Agencies, Commissions, Rents for Buildings, Yards, etc	4.66
35	Stationery and Printing	0.53
		49.36
36	Taxes Paid	5.64
37	General Expenses	4.38
	Grand Total	100.00

Average Cost per Train Mile for the Four Years $1.17

also shown, and this cost is divided between the items of the table according to the percentages shown.

Before proceeding to consider the value of gradients, distance, etc., it is necessary to obtain some basis for arriving at the proportional percentages of the more important items that are affected by changes in location. In many of the smaller items judgment alone has to be used, and in most of such cases a wide variation in judgment will produce but a slight change in the final figures. In the larger items of Maintenance of Way, Maintenance of Equipment and Conducting Transportation, the reports of the various departments for the four years covered by Table No. 1 have been studied and the conditions as they exist on the Union Pacific have been considered. The reasons for adopting these percentages are given in detail in Wellington's "Economic Theory of Railway Location." Tables Nos. 2, 3 and 4, together with the following notes, give some additional reasons, and also explain those points wherein percentages different from Wellington's have been used.

Maintenance of Way.—Total side track mileage is about 34 per cent. of mileage of main track. One-half of side track mileage is in large yards and terminals, the balance being side tracks at intermediate stations. There is probably about one-third as much labor spent on repairs of side tracks as on the same length of main track. The same is assumed to be true of material; hence in these calculations it will be assumed that labor and material in repairs of roadbed and track are distributed as follows:

Main track	90 per cent.
Large yards and terminals	5 per cent.
Smaller stations	5 per cent.
Total	100 per cent.

Maintenance of Equipment.—From the annual locomotive performance sheets and statistics of train service it is found that total train mileage is but 75 per cent. of total locomotive mileage. Table No. 2 is similar to a table given by Wellington, the total cost of locomotive repairs being prorated between the different classes of service according to mileage. The distribution with reference to contributing causes is changed somewhat to fit the conditions on the Union Pacific, curvature on the Union Pacific averaging 17 degrees per mile, whereas Wellington assumed 30 degrees per mile.

Conducting Transportation.—As only 75 per cent. of engine mileage enters into total train mileage, the wages of engine and roundhouse men due directly to hauling trains with single engine are assumed as 75 per cent. of the whole.

In train service only about 75 per cent. of the crews are paid on a mileage basis, the balance being on monthly wages, and any increase of distance, unless it be great, would affect only 75 per cent. of this item.

Fuel, water, oil and waste are covered by Table No. 4.

General Explanation.—It must be thoroughly understood that the total train mileage includes the mileage of all passenger, freight, work and special trains, whether revenue or non-revenue. In the calculations as to the effect of the various details of location on operating expenses a single train is considered with a single locomotive. Therefore, none of the expense connected with helper, switch or light engine enters into the calculation, and only that proportion of the remainder of each item of operating expenses which is affected by gradient, distance, curvature, etc., is considered.

TABLE NO. 2.

Statement Showing Distribution of Cost of Locomotive Repairs on Union Pacific Railroad.

CLASS OF SERVICE.	Per Cent. Repairs Charged Each Class.	Distribution of Contributing Causes in Per Cent.					
		Time and Exposure.	Stopping and Starting.	Getting up Steam and Terminal Work.	Average Curvature.	Average Grades.	Distance.
Passenger.....	31.50	2.20	4.73	5.35	0.95	4.41	13.86
Freight and Work..	43.25	3.03	6.49	7.35	1.30	6.05	19.03
Helpers..	5.46	0.38	0.82	0.82	0.16	2.18	1.10
Light Engines*....	6.38	0.45	0.64	1.08	0.19	0.32	3.70
Switching.....	13.41	0.94	....	12.47	....	....	....
	100.00	7.00	12.68	27.07	2.60	12.96	37.69

* Light Engine Mileage includes return of helper engines.
Only the first two classes enter into train mileage.

Any increase in repairs and renewals of shop machinery and tools caused by increase in gradients, distance or curvature is considered as proportional to the increase in repairs and renewals of locomotives and cars.

TABLE NO. 3.

Statement Showing Distribution of Cost of Car Repairs on Union Pacific Railroad.

CLASS OF SERVICE.	Total Cost per Cent.	Distribution of Contributing Causes in Per Cent.					
		Time and Exposure.	Stopping and Starting.	Switching.	Curvature.	Grades.	Distance.
Passenger.....	100	11	20	11	2	20	36
Freight and Work....	100	6	20	16	2	20	36

TABLE NO. 4.

Statement showing Average Percentage Per Year of Various Classes of Engine Mileage and Percentages of Fuel, Water, Oil, Waste and Engine Supplies Used by Each Class, with Distribution of Same, for the Four Years Ending June 30th, 1902.

CLASS OF SERVICE.	Per Cent. Mileage Each Class.	Fuel Used Each Class Service.							Water, Oil, Waste and Locomotive Supplies.					
		Per Cent. Used.	Distribution, Per Cent of Whole.						Per Cent Used	Distribution, Per Cent of Whole.				
			Starting and Banking Fires.	Waste, Standing	Stopping and Starting.	Average Curvature.	Average Grade.	Distance.		Waste, All Sources.	Stopping and Starting.	Average Curvature.	Average Grade.	Distance.
Passenger.....	31.50	25	1.25	0.75	2.50	.37	5.00	15.13	28	1.40	3.08	.42	5.60	17.50
Freight and Mixed.	40.08	46	2.30	1.38	4.60	.69	9.20	27.83	43	2.15	4.73	.64	8.60	26.88
Work Trains.....	3.17	4	.20	.12	.40	.06	.80	2.42	4	.20	.44	.06	.80	2.50
Helpers.....	5.46	10	.50	.30	1.00	.15	2.00	6.05	8	.40	.88	.12	1.60	5.00
Light Engines.....	6.38	3	.15	.09	.30	.05	.60	1.81	5	.25	.55	.08	1.00	3.12
Switching.....	13.41	12	.60	.36	1.20	.18	2.40	7.26	12	.60	1.32	.18	2.40	7.50
Totals.....	100.00	100	5.00	3.00	10.00	1.50	20.00	60.50	100	5.00	11.00	1.50	20.00	62.50

The first three classes of service are the classes that total train mileage is calculated from. Total train mileage averaged 74.75 per cent. of total engine mileage.

Per cent. fuel, water, oil, etc., used is based on the statements of locomotive performance for the four years. Helper mileage is mileage of actual helping, the return of helpers being included in light engines.

The distribution of the use of fuel, etc., is according to the theory of Wellington, the percentages used being changed somewhat to fit the conditions on Union Pacific.

GRADIENTS.

The most important engineering problem affecting the operating expenses of a road is the question of the ruling gradient to be adopted. On short changes of line this question does not enter into consideration, as the maximum grade is always held within the limits allowed by the ruling grade of the engine district. On new lines, and on changes of line of some magnitude, it is an extremely important question. The ruling grade of an engine district governs the number of trains necessary to handle the traffic of that district, and should never be exceeded except where the character of the country is such as to make "helper grades" advisable. Any change that may be made in a line to reduce the ruling gradient will reduce the number of trains required to handle a given traffic. To get at the value of changes in ruling gradient the additional cost of running one more train per day to handle a given traffic will be considered.

As many items of expense will not be affected, the cost per train mile for the additional train will not be as large as the average cost per train mile for the entire traffic. Table No. 5 considers the percentage of the items of operating expenses which are affected by such an additional train as applied to the operating expenses per train mile on the Union Pacific Railroad.

The saving per annum due to a reduction of gradient so that one less daily train in each direction can handle a given traffic will be as follows:

$0.51 × twice the length of engine district × 365. Multiplying this product by the number of round-trip daily trains saved, and dividing by the interest rate, will give the justifiable expenditure to make the proposed reduction in gradient.

In order to find the number of freight trains saved by any reduction of gradient, it will first be necessary to ascertain the total trainload that can be hauled on different gradients by a given engine. Freight trains are of two classes, fast and slow. The slow freights are given the maximum tonnage that can be hauled on the ruling gradient at a maintained speed of 10 or 12 miles per hour. Fast freights are given the train that can be hauled at a much higher velocity. Both classes would be affected by any change in gradient. Six pounds per ton of train is taken as a fair average for velocity and frictional resistance, equivalent to a speed of about 16 miles per hour. To get at the number of trains necessary to handle a given traffic it is necessary to find what weight of train, exclusive of engine and caboose, can be handled by the engines used on the district. This is found as follows:

$$\text{Weight in tons} = \frac{\text{Pounds Tractive Power}}{\text{Total pounds resistance per ton}} - \text{Weight of engine, tender and caboose in tons.}$$

TABLE NO. 5.

Cost per Train Mile for an Additional Train to Handle a Given Traffic.

Item No.	ITEM.	Normal Average Cost Per Cent.	Proportion Affected, %	Per Cent. Cost per Train Mile for Additional Train.
1	Ballast	0.28	0	....
2	Frogs and Switches	0.35	50	0.18
3	Protection of River Banks	0.03	0	....
4	Repairs of Roadbed and Track	8.33	50	4.16
5	Repairs of Snow Fences, etc	0.10	0	....
6	Spikes and Rail Fastenings	0.86	50	0.43
7	Superintendence (M. of Way)	0.55	0	....
8	Renewals of Rails	2.28	50	1.14
9	Renewals of Ties	3.01	50	1.50
10	Rep. and Renewals, Bridges and Culverts	1.81	5	0.09
11	" " " Road Crossings, Cattle Guards, etc	0.32	0	....
12	" " " Buildings, etc	1.99	0	....
13	" " " Telegraph	0.15	0	....
14	Stationery and Printing (M. of Way)	0.01	0	....
15	Superintendence (M. of Equipment)	0.63	0	....
16	Repairs and Renewals, Locomotives	10.19	70	7.13
17	" " " Passenger Cars	2.07	0	....
18	" " " Freight Cars	5.32	—5	—0.27
19	" " " Work Cars	0.51	0	....
20	" " " Machinery and Tools	1.03	35	0.36
21	Stationery, etc. (M. of Equipment)	0.80	0	....
22	Superintendence (Transportation)	1.50	0	....
23	Engine and Round-house Men	10.10	75	7.58
24	Fuel for Locomotives	10.80	75	8.10
25	Water, Oil, Waste and Supplies (locomo.)	1.36	75	1.02
26	Train Service	5.55	100	5.55
27	Train Supplies and Expenses	1.91	90	1.72
28	Switchmen, Flagmen, etc	2.36	50	1.18
29	Telegraph Expenses	2.44	20	0.49
30	Station Service and Supplies	5.62	20	1.12
31	Car Mileage	0.61	0	...
32	Hire of Equipment	0.04	0	....
33	Loss and Damage, etc	1.88	75	1.41
34	Advertising, Agencies, etc	4.66	0	....
35	Stationery, etc. (Transportation)	0.53	75	0.40
36	Taxes	5.64	0	....
37	General Expenses	4.38	0	....
	Total Per Cent	100.00		43.29

Cost per train mile for additional train: 43.29% of $1.17	$0.50
Add interest on cost of additional locomotive and caboose per train mile	.01
Total cost per train mile for additional train	$0.51

For each engine going over a district one must be returned in order to keep power equalized. To reduce train mileage it would be necessary to reduce the grade, so that for every train less in one direction there would be one less train in the opposite direction; or, in other words, there must be two train miles saved for each track mile of engine district.

Table No. 6 gives this weight in tons for one of the modern Union Pacific locomotives.

TABLE NO. 6.

Total Weight of Train Between Engine Tender and Caboose for Various Gradients, for Locomotive and Tender Weighing 150.3 Tons in Working Order; Tractive Power, 35,268 Pounds; Weight of Caboose, 17 Tons; Velocity and Frictional Resistance, 6 Pounds per Ton.

Gradient. Per Cent.	Weight of Train. Tons.	Gradient. Per Cent.	Weight of Train. Tons.	Gradient. Per Cent.	Weight of Train. Tons.
0.4	2352	1.0	1190	1.6	761
0.5	2037	1.1	1092	1.7	714
0.6	1792	1.2	1008	1.8	672
0.7	1596	1.3	935	1.9	634
0.8	1436	1.4	870	2.0	599
0.9	1302	1.5	812		

No advantage except a reduction in time would be gained by reducing grade below 0.4 per cent., as starting resistance of train on level would limit the weight of train. For other locomotives of modern type the weight of train would vary, depending on the tractive power, but the percentage of reduction in weight for increased grade would vary only slightly from the above.

Table No. 7 is deduced from Table No. 6. The first column gives the gradient that it is proposed to reduce. The following columns give the percentage of trains necessary to handle the same traffic if grade is reduced to that given at the head of each column. Values for intermediate grades can be obtained by interpolation.

Example:

An engine district 100 miles long has ruling gradient of 1 per cent. in each direction. The freight traffic requires 10 daily trains each way. What expenditure would be justifiable to reduce the ruling gradient to 0.8 per cent., with interest rate at 5 per cent. per annum?

From Table No. 7 it is found that it would require only 83 per cent. of the number of trains to handle the traffic on an 0.8 per cent. grade that would be required on a 1 per cent. grade. This is a saving of 17 per cent., or 1.7 trains each way per day. By the rule deduced from Table No. 5 the annual saving would be $\$0.51 \times 200 \times 365 \times 1.7 = \$63,291$.

This sum capitalized at 5 per cent. is equal to $1,265,820, the expenditure justifiable to reduce the gradient.

In the above example the traffic is assumed as evenly balanced both ways. The same value would be obtained if the district considered was continually rising from one terminal to the other with the same ruling gradient, as a reduction of the gradient would reduce the number of engines and cabooses returning over the district either light or only partially

TABLE NO. 7.

Table Showing Per Cent. of Trains Necessary to Handle a Given Traffic with Single Engine, if Gradients Are Changed from Those in First Column to Any Other Given Gradient.

Gradient to be Reduced, Per Cent.	Proposed Gradient, Per Cent., with Per Cent. of Trains to Handle same Traffic as on Original Gradient.																
	+0.4	+0.5	+0.6	+0.7	+0.8	+0.9	+1.0	+1.1	+1.2	+1.3	+1.4	+1.5	+1.6	+1.7	+1.8	+1.9	+2.0
2.0	26	30	34	38	42	46	51	55	60	65	69	74	79	84	89	95	100
1.9	27	31	36	40	44	49	54	58	63	68	73	78	84	89	95	100	
1.8	29	33	38	42	47	52	57	62	67	72	78	83	89	94	100		
1.7	31	35	40	45	50	55	60	66	71	77	82	88	94	100			
1.6	33	37	43	48	53	59	64	70	76	82	88	94	100				
1.5	35	40	46	51	57	63	68	75	81	87	93	100					
1.4	37	43	49	55	61	67	73	80	87	93	100						
1.3	40	46	53	59	66	72	79	86	93	100							
1.2	43	50	57	64	71	78	85	92	100								
1.1	47	54	61	69	76	84	92	100									
1.0	51	59	67	75	83	91	100										
·0	55	64	73	82	91	100											
·0.8	61	71	80	90	100												
0.7	68	79	89	100													
0.6	76	88	100														
0.5	87	100															
0.4	100																

loaded. From the foregoing it will be seen that whatever effort is put forth to reduce gradient should be expended in a manner to balance traffic as nearly as possible.

Ordinary changes in ruling gradients do not affect passenger trains materially except as to fluctuations in speed. The number of passenger trains depends but very little on ruling gradient and should be left out of the question in calculation of values of grade reduction, except where the grade can be reduced to such an extent as to entirely abolish the use of helper engine on passenger trains. In this case the saving can only be figured on the basis of reduction of cost of helper engines.

HELPER GRADES.

In some instances there exist topographical features that make necessary a gradient considerably in excess of the ruling gradient on the balance of the district. The reduction of this heavy gradient to the ruling gradient of the district might be so expensive as to be impracticable. Such grades are operated by a helper engine, and are called "helper grades." The use of the helper engine creates additional cost, and occasionally the cost is such that maintaining the helper grade is a greater annual expense than the interest on the cost of reducing the same to the ruling gradient, the helper engine having to pass twice over the grade for each train assisted.

Each case must be considered by itself and the most economical method of operation should be adopted, the grades being adjusted to such method.

The greatest efficiency in helper engines is secured when the helper is kept constantly at work. To secure this efficiency the helper grade should be as nearly continuous and uniform as possible, rather than with stretches of lighter grade between grades where helper is necessary. The rate of helper grade should be such as to require the full power of the helper engine in addition to that of the regular engine to handle the maximum train that can be hauled by one engine over the balance of the district. This reduces the length of the necessary helper grade and consequently the helper engine mileage.

For two engines of the same class the combined theoretical tractive power would be double what one engine would exert, but in practice it is not safe to assume this. A conservative estimate would be that only 90 per cent. of the tractive power can be available in the helper engine. This 90 per cent. can not be wholly applied to lifting the train load, as part of it is required for overcoming resistance due to the weight of the locomotive. The amount used this way varies slightly with the type of engine and size of tender, but the following is a fairly accurate statement showing ruling gradient for one engine and equivalent helper gradient for same train and same class helper engine, counting 90 per cent. of tractive power of helper engine and velocity resistance of 5 pounds per ton of train, equivalent to 12 miles per hour maintained speed for maximum train.

Ruling Gradient, One Engine.....	0.50%	0.60%	0.70%	0.80%	0.90%	1.00%
Equivalent Gradient, One Helper..	1.09%	1.25%	1.41%	1.58%	1.73%	1.89%

If conditions are such that the helper grade is heavier or lighter than that given above as equivalent to the ruling grade with one engine, the helper engine should be correspondingly heavier or lighter in order to attain the greatest economy in operation.

On some roads of very light traffic it may not be economical to maintain helper engines at points where it has been considered necessary to establish helper grades with a view to future growth. In such cases the engine will "double" the grade, taking part of the load at each trip, but where a helper engine can be kept fairly busy it would be best to maintain the helper service. Usually a helper engine will make a daily mileage equal to the average freight engine mileage for the district, or from 100 to 125 miles per day.

The cost of helper engine service depends partly on the miles run, but some items are wholly independent of mileage. The maintenance of way items will be affected the same as for an additional engine to care for a given traffic, as shown in Table No. 5. Wages of engine and round-house men for helper service are independent of distance; fuel and locomotive supplies will be at a higher rate except where engine is kept busy; locomotive repairs will mainly depend on mileage. There is a wide chance for variation in cost of helper engine mileage, and on operated lines where such service is maintained the actual cost of Maintenance of

TABLE NO. 8.

Estimated Cost of a Helper Engine Mile in Per Cent. of Cost of a Normal Train Mile.

Item. No.	ITEM	Normal Average Cost. Per Cent.	Proportion Affected. %	Cost per Helper Engine Mile. Per Cent.
2	Frogs and Switches	0.35	50	0.18
4	Repairs, Roadbed and Track	8.33	50	4.16
6	Spikes and Rail Fastenings	0.86	50	0.43
8- 9	Renewals of Rails and Ties	5.29	50	2.64
10	Repairs and Renewals, Bridges and Culverts.	1.81	5	0.09
16	Repairs and Renewals, Locomotives	10.19	75	7.64
23	Engine and Round-house Men	10.10	75	7.58
24-25	Fuel, Water, etc., Locomotives	12.16	75	9.12
28	Switchmen, Flagmen and Watchmen	2.38	50	1.19
29	Telegraph Expenses	2.44	20	0.49
	Total	.....	.....	33.52

Cost per helper engine mile, 33.52% of $1.17 ..... $0.392
Add interest on cost of engine, approximate cost per mile 0.010

Total $0.402

Cost per helper engine mile per annum, $0.402 × 365 = $146.73.
As helper must run light on return trip, the cost of helper service per train mile assisted train per annum would be $146.73 × 2 = $293.46.

Equipment and Conducting Transportation should be obtained for use in calculations and added to the estimated cost of Maintenance of Way. The estimate given in Table No. 8 is a conservative one for a fairly busy helper engine.

Multiplying these figures by the total helper engine mileage or by the total train miles of assisted train will give cost per annum for helper service. Dividing this cost by the interest rate will give the justifiable expenditure to reduce the helper grade to the ruling grade of the balance of the district.

Where it is not advisable or economical to reduce a helper grade to the proposed ruling gradient for single engine, the line and grades on either side should be adjusted so that when the business justifies the change it can be made without rebuilding any more than the portion where the helper grade is located.

DISTANCE.

The various items in Table No. 1 are not affected equally by changes in length of line. Some are not affected in the least, while others will vary directly with increase or decrease in distance. Where the change in distance is so small as not to affect the number of engine districts or large yards, only the labor and material used in main track and intermediate yards will be affected.

Tables 2, 3 and 4 show the per cent. of charges to locomotive and car repairs and locomotive fuel and supplies that can be reasonably assumed as due to distance. Switch engine mileage will not be affected and helper engine service has been considered, so the only classes of service to be considered are passenger, freight and work trains.

On very short changes in distance, the wages of enginemen and trainmen will not be affected, neither will some of the items of maintenance of way. On longer changes these items will be affected, and on changes so great as to affect the number of stations and sidings still further items will be affected. Therefore, changes in distance will be considered under three classes, viz.:

Class "A"—Distances so short as not to affect train wages.
Class "B"—Distances affecting train wages, but not so great as to affect the number of stations or sidings required.
Class "C"—Distances so great as to affect the number of stations and sidings required.

Table No. 9 shows the estimated cost per train mile for increase in distance for each class, from which costs per daily train per annum are deduced.

Multiplying the cost per daily train one way, per annum, by the sum of the number of trains in each direction, and dividing this product by the interest rate, will give the justifiable expenditure to eliminate one foot of distance for Class "A," or one mile of distance for Classes "B" and "C."

TABLE No. 9.

Effect on Operating Expenses of Changes in Distance.

Class "A" Distances so short as not to affect wages of engine or train men.
Class "B" Distances affecting train wages, but not requiring additional side tracks.
Class "C" Distances so great as to require additional side tracks and station.

Item No.	ITEM.	Normal Average Cost Per Cent.	Proportion of Whole Affected, %			Added Proportional Cost for One Train Mile, Per Cent.		
			A	B	C	A	B	C
1	Ballast	0.28	95	95	100	0.27	0.27	0.28
2	Frogs and Switches	0.35	0	0	50	.....	.....	0.17
3	Protection of River Banks	0.03	100	100	100	0.03	0.03	0.03
4	Repairs, Roadbed and Track	8.33	90	90	95	7.50	7.50	7.92
5	" Snow Fences, etc	0.10	100	100	100	0.10	0.10	0.10
6	Spikes and Rail Fastenings	0.86	90	90	95	0.77	0.77	0.82
7	Superintendence (M. of Way)	0.55	0	0	0	.....	.....	.....
8	Renewals of Rails	2.28	90	90	95	2.05	2.05	2.17
9	" of Ties	3.01	90	90	95	2.71	2.71	2.86
10	Rep. and Renewals, Bridges and Culverts	1.81	0	100	100	.....	1.81	1.81
11	Rep. and Renewals, Road Crossings, Cattle Guards, etc	0.32	0	90	95	.....	0.29	0.30
12	Rep. and Renewals, Buildings, etc	1.99	0	0	30	.....	.....	0.60
13	" " " Telegraph	0.15	60	60	75	0.09	0.09	0.11
14	Stationery and Printing (M. of Way)	0.01	90	90	95	0.01	0.01	0.01
15	Superintendence (M. of Equipment)	0.63	0	0	0	.....	.....	.....
16	Rep. and Renewals, Locomotives	10.19	33	33	44	3.36	3.36	4.48
17	" " " Passenger Cars	2.07	36	36	56	0.75	0.75	1.16
18	" " " Freight Cars	5 32	36	36	56	1.91	1.91	2.98
19	" " " Work Cars	0.51	36	36	56	0.18	0.18	0.28
20	" " " Machinery, etc	1.03	34	34	49	0.35	0.35	0.50
21	Stationery, etc. (M. of Equipment)	0.80	34	34	49	0.27	0.27	0.39
22	Superintendence (Transportation)	1.50	0	0	0	.....	.....	.....
23	Engine and Round-house Men	10.10	0	75	75	.....	7.58	7.58
24	Fuel for Locomotives	10.80	45	45	55	4.86	4.86	5.94
25	Water, Oil, etc., for Locomotives	1.36	45	45	55	0.61	0.61	0.75
26	Train Service	5.55	0	75	75	.....	4.16	4.16
27	" Supplies and Expenses	1.91	50	50	50	0.95	0.95	0.95
28	Switchmen, Flagmen, etc	2.36	0	0	50	.....	.....	1.18
29	Telegraph Expenses	2.44	20	20	20	0.49	0.49	0.49
30	Station Service and Supplies	5.62	0	0	80	.....	.....	4.50
31	Car Mileage	0.61	100	100	100	0.61	0.61	0.61
32	Hire of Equipment	0.04	0	0	0	.....	.....	.....
33	Loss and Damage, etc	1.88	75	75	75	1.41	1.41	1.41
34	Advertising, Agencies, etc	4.66	0	0	0	.....	.....	.....
35	Stationery, etc. (Transportation)	0.53	0	0	0	.....	.....	.....
36	Taxes	5.64	50	50	80	2.82	2.82	4.51
37	General Expenses	4.38	0	0	0	.....	.....	.....
	Total, Per Cent	100.00				32.10	45.94	59.05

Cost per additional train mile of each class:

Class "A" 32.10% of \$1.17 = \$0.3756
Class "B" 45.94% of \$1.17 = \$0.5375
Class "C" 59.05% of \$1.17 = \$0.6909

The additional cost per annum per daily train one way would be:

Class "A" $\frac{0.3756 \times 365}{5280} = \$0.026$ for each additional foot of distance.
Class "B" $\$0.5375 \times 365 = \$196.19$ for each additional mile of distance.
Class "C" $\$0.6909 \times 365 = \$252.18$ for each additional mile of distance.

CURVATURE.

No logical value can be placed on the elimination of a single curve where the total degrees of curvature are not reduced. Where a curve is located in a particularly dangerous place, requiring a watchman or other additional expense for protection, its elimination would have a value, but each case would have to be considered by itself. In comparing the relative values of two lines, unless the curve is particularly dangerous, it is best to consider only the value of reducing the total degrees of curvature.

To get at the value of curvature it will be treated as an increase, and the increase to operating expenses noted.

Average train resistance can be safely assumed as about 10 pounds per ton. This is equivalent to a velocity of about 28 miles per hour on a level tangent. Curvature on the Union Pacific is compensated at 0.04 foot per degree of curvature (equivalent to 0.8 pounds per ton of train). The resistance on a 12° 30′ curve would be 10 pounds per ton, hence on a 12° 30′ curve with level track resistance would be twice the average. To find the value for elimination of a degree of curvature, the addition to operating expenses due to one mile of 12° 30′ curve with a total angle of 660 degrees is considered in Table No. 10.

Tables 2, 3 and 4 show the average per cent. of charges per train mile against passenger, freight and work trains due to average curvature, but for a train mile having 660 degrees of curvature there is 40 times the average amount.

Multiplying the cost per daily train one way per degree, per annum, by the sum of the number of trains in each direction, and dividing this product by the interest rate, will give the justifiable expenditure to eliminate one degree of curvature.

RISE AND FALL.

In considering the value of Rise and Fall it will be divided into three classes, as given by Wellington:

Class "A" includes all cases where grades are so light or so short as not to require the use of brakes or variation in the working of the engine.

Class "B" includes all cases where grades are such as to require shutting off steam in descending, but are not long enough to require application of brakes to prevent exceeding the maximum safe speed.

Class "C" includes all cases where grades are so heavy as to necessitate not only shutting off steam, but the application of brakes in descending.

One foot up and one foot down is called one foot of rise and fall. It will be seen in considering velocity and virtual grades that the number of feet rise and fall for any particular class will vary with the actual grade, the speed of approach and the controlling grade of the line under consideration. To get at the true class a virtual profile should be worked

TABLE No. 10.

Effect on Operating Expenses of One Mile of 12° 30′ Curve.

(Total angle 660 degrees.)

Item No.	ITEM.	Normal Average Cost, Per Cent.	Proportion Affected, %	Additional Cost Due to Curvature, Per Cent.
1	Ballast	0.28	50	0.14
2	Frogs and Switches	0.35	0	....
3	Protection of River Banks	0.03	0	....
4	Repairs of Roadbed and Track	8.33	50	4.17
5	Repairs of Snow Fences, etc	0.10	0	....
6	Spikes and Rail Fastenings	0.86	100	0.86
7	Superintendence (M. of Way)	0.55	0	....
8	Renewals of Rails	2.28	300	6.84
9	Renewals of Ties	3.01	50	1.50
10	Rep. and Renewals, Bridges and Culverts	1.81	0	....
11	" " " Road Crossings, Cattle Guards, etc	0.32	0	....
12	" " " Buildings, etc	1.99	0	....
13	" " " Telegraph	0.15	0	....
14	Stationery and Printing (M. of Way)	0.01	0	....
15	Superintendence (M. of Equipment)	0.63	0	....
16	Repairs and Renewals, Locomotives	10.19	90	9.17
17	" " " Passenger Cars	2.07	80	1.66
18	" " " Freight Cars	5.32	80	4.25
19	" " " Work Cars	0.51	80	0.41
20	" " " Machinery and Tools	1.03	85	0.88
21	Stationery, etc. (M. of Equipment)	0.80	0	....
22	Superintendence (Transportation)	1.50	0	....
23	Engine and Round-house Men	10.10	0	...
24	Fuel for Locomotives	10.80	45	4.86
25	Water, Oil, Waste and Supplies, Locomo	1.36	45	0.61
26	Train Service	5.55	0	....
27	Train Supplies and Expenses	1.91	0	....
28	Switchmen, Flagmen, etc	2.36	0	....
29	Telegraph Expenses	2.44	0	....
30	Station Service and Supplies	5.62	0	....
31	Car Mileage	0.61	0	....
32	Hire of Equipment	0.04	0	....
33	Loss and Damage, etc	1.88	0	....
34	Advertising, Agencies, etc	4.66	0	....
35	Stationery, etc. (Transportation)	0.53	0	....
36	Taxes	5.64	0	....
37	General Expenses	4.38	0	....
	Total Per Cent	100.00		35.35

Where curvature is compensated for grade, the increase for Fuel, Water, etc., will be cut out, making the increased cost for the one mile of curvature 29.88%

Additional Cost for the Train Mile on 12° 30′ curve:

35.35% of \$1.17 = \$0.4136 for uncompensated curvature.

29.88% of \$1.17 = \$0.3496 for compensated curvature.

Cost per degree, per daily train, per annum:

$\frac{0.4136 \times 365}{660}$ = \$0.23 for uncompensated curves.

$\frac{0.3496 \times 365}{660}$ = \$0.19⅓ for compensated curves.

up for each line. For estimating purposes the following limits for the divisions will be adopted:

Class "A:" All rise and fall up to 30 feet. This class of rise and fall adds so little to the operating expenses that it need not be considered in comparing value of lines.

Class "B:" All rise and fall of over 30 feet on grades of less than 0.6 per cent., since the maximum velocity that can be attained on a 0.6 per cent. grade by a train dropping of its own weight is about 32 miles per hour, for at this velocity the train resistance just equals the force of gravity. Owing to the fact that curves may be located near the bottom of grades, the maximum safe speed will be considered at about 30 miles per hour. On grades of 0.6 per cent. and over, the following figures show the approximate distances trains would run with steam shut off and with initial speed of 10 miles per hour before reaching 30 miles per hour speed, the distance run being given in stations of 100 feet:

Gradient....	— 0.6%	— 0.7%	— 0.8%	— 0.9%	— 1.0%	— 1.25%	— 1.50%
Distance...	170 Sta.	100 Sta.	73 Sta.	57 Sta.	48 Sta.	33 Sta.	26 Sta.
Total Drop..	102 ft.	70 ft.	58 ft.	51 ft.	48 ft.	41 ft.	38 ft.

On above gradients all rise and fall of over 30 feet and up to above total drop belong to Class "B."

Class "C:" All rise and fall on grades of 0.6 per cent. and over in excess of total drop given in above statement.

The average resistance of a train is about 10 pounds per ton of train, equivalent to the resistance on a level tangent at a velocity of 28 miles per hour. The resistance due to grade alone on a 0.5 per cent. grade is 10 pounds per ton. Therefore, the total resistance on a mile of 0.5 per cent. grade is double the resistance on one mile of level tangent.

To get at the value of rise and fall it will be assumed that there are two miles of tangent, the first mile having an ascending grade of 0.5 per cent. and the second mile a descending grade of the same rate, the two miles containing 26.4 feet of rise and fall. Table No. 11 shows the estimated additional cost per train mile due to this 26.4 feet of rise and fall, from which values are deduced for one foot of rise and fall of each class

TABLE No. 11.

Effect on Operating Expenses of One Mile Containing 26.4 Feet of Rise and Fall.

Item No.	ITEM.	Normal Average Cost, Per Cent.	Proportion of Whole Affected, %		Additional Cost for 26.4 Feet Rise and Fall, Per Cent.	
			Class B	Class C	Class B	Class C
1	Ballast	0.28	0	5	.....	0.01
2	Frogs and Switches	0.35	0	0	.....	.....
3	Protection of River Banks	0.03	0	0	.....	.....
4	Repairs of Roadbed and Track	8.33	0	5	.....	0.42
5	Repairs of Snow Fences, etc	0.10	0	0	.....	.....
6	Spikes and Rail Fastenings	0.86	5	10	0.04	0.09
7	Superintendence (M. of Way)	0.55	0	0	.....	.....
8	Renewals of Rails	2.28	5	10	0.11	0.23
9	Renewals of Ties	3.01	0	5	....	0.15
10	Rep. and Renewals, Bridges and Culverts.	1.81	0	0	.....	.....
11	" " " Road Crossings, Cattle Guards, etc	0.32	0	0	.....	.....
12	" " " Buildings, etc	1.99	0	0	.....	.....
13	" " " Telegraph	0.15	0	0	.....	.....
14	Stationery and Printing (M. of Way)	0.01	0	0	.....	.....
15	Superintendence (M. of Equipment)	0.63	0	0	.....	.....
16	Repairs and Renewals, Locomotives	10.19	1	4	0.10	0.41
17	" " " Passenger Cars	2.07	1	4	0.02	0.08
18	" " " Freight Cars	5.32	1	4	0.05	0.21
19	" " " Work Cars	0.51	1	4	0.01	0.02
20	" " " Machinery and Tools	1.03	1	4	0.01	0.04
21	Stationery, etc. (M. of Equipment)	0.80	0	0	.....	.....
22	Superintendence (Transportation)	1.50	0	0	.....	.....
23	Engine and Round-house Men	10.10	0	0	.....	.....
24	Fuel for Locomotives	10.80	25	45	2.70	4.86
25	Waste, Oil, Water and Supplies, Locomo.	1.36	25	45	0.34	0.61
26	Train Service	5.55	0	0	.....	.....
27	Train Supplies and Expenses	1.91	0	0	.....	.....
28	Switchmen, Flagmen, etc	2.36	0	0	.....	.....
29	Telegraph Expenses	2.44	0	0	.....	.....
30	Station Service and Supplies	5.62	0	0	.....	.....
31	Car Mileage	0.61	0	0	.....	.....
32	Hire of Equipment	0.04	0	0	.....	.....
33	Loss and Damage, etc	1.88	0	0	.....	.....
34	Advertising, Agencies, etc	4.66	0	0	.....	.....
35	Stationery, etc. (Transportation)	0.53	0	0	.....	.....
36	Taxes	5.64	0	0	.....	.....
37	General Expenses	4.38	0	0	.....	.....
	Total, Per Cent	100.00			3.38	7.13

Additional Cost per train mile due to the Rise and Fall:

Class "B" 3.38% of $1.17 equals $0.0395.

Class "C" 7.13% of $1.17 equals $0.0834.

If the rise and fall is on gradients equal to or in excess of the ruling gradient, add 3 cents per train mile to above for wear and tear of rolling stock and track, making Class "B" 6.95 cents and Class "C" 11.34 cents per train mile.

Additional cost per annum of one foot rise and fall, per daily train, one way:

On Minor Grades.

Class "B" $\frac{.0395 \times 365}{26.4} = \$0.55$

Class "C" $\frac{.0834 \times 365}{26.4} = \$1.15$

On Ruling Grades.

Class "B" $\frac{.0695 \times 365}{26.4} = \$0.96$

Class "C" $\frac{.1134 \times 365}{26.4} = \$1.57$

Multiplying the above costs per foot of rise and fall by the total number of trains in both directions, and dividing by the interest rate, will give the justifiable expenditure to eliminate one foot of rise and fall.

In using the values for elimination of rise and fall, the engineer must bear in mind that rise and fall for heavy freight trains may lie in Class "B" or "C," while for passenger trains it may lie in the less expensive class, owing to the higher velocity allowed passenger trains. This is best determined by platting the virtual grade line for each class of train. The profile herewith illustrates the different classes of rise and fall on ruling gradients for the maximum train that can be hauled on an 0.82 per cent. grade at a maintained speed of 10 miles per hour. While the illustration shows gradients in excess of the ruling gradient, they are not advisable. The Class "A" drops shown would be practically harmless, except when an emergency arose to require the checking of speed, in which case they would prove expensive.

TRAIN RESISTANCE.

There are many formulas for train resistance, giving widely different results. In a number of experiments conducted by Wellington it was found that, at a given velocity, the resistance in pounds per ton of train varied with the type, load and number of cars in the train, or that, in two trains of the same gross weight but with a different number or type of cars, the resistances will be different at the same velocity.

Wellington's formula for resistance in pounds per ton for loaded trains is as follows:

$$R = 4 + .005\,V^2 + (.28 + .03\,N)\frac{V^2}{W}$$

R—Resistance in pounds per ton; V=Velocity in miles per hour; N—Number of cars to train; W=Weight of train in 2000-pound tons.

The first term represents the journal and rolling friction, the second term the resistance due to oscillation and concussion, and the third term atmospheric resistance.

Recent experiments by the Pennsylvania Railroad would indicate that this journal resistance is too high for modern cars having a gross weight of 30 tons or more. A modern coal car with 40 to 50 tons of coal will not have a journal friction of more than 2½ pounds per ton, while the same car empty will have a journal friction of about 5 pounds per ton. As trains are made up varying in amount of weight per car and number of cars, an empirical formula for resistance is given

by Wellington which is generally used in the calculation of resistance in computing tonnage for a given tractive power. This formula is $R=4+\frac{V^2}{130}$ This formula gives a value for the resistance which is conservative for the average train at velocities from 5 to 35 miles per hour, although many recent experiments would indicate that the resistances at the higher velocities are not so great as the formula would indicate. For the purposes used herein the formula gives a "factor of safety," as any revision of grade in which this formula is used in constructing a virtual profile can be operated with greater ease by a train in case the resistances are less than those given by the formula.

When trains have been standing still for several minutes, the starting resistance is as high as 18 or 20 pounds per ton of train, but this resistance rapidly decreases as the train gets under motion. In case the ruling gradient of a district is very light, the maximum train load may be limited by this starting resistance, but the entire mass of the train is not started at the same instant, owing to the spring of the couplings, so that the grade line at a station need not be adjusted to the full amount that theory would indicate in order to facilitate the starting of trains. Where practicable, it is advisable to make the gradient through the station grounds, and for a train length outside of the switches at least 0.4 per cent. less than the ruling gradient.

In addition to the velocity and frictional resistances there is grade resistance. This, expressed in pounds per ton of train, is 20 times the rate per cent. of grade.

The total resistance to be overcome would then be represented by the formula:

$$R = 4 + \frac{V^2}{130} + 20 \text{ times rate per cent. of grade.}$$

TRACTIVE POWER OF LOCOMOTIVES.

Formula: Tractive Power $= \frac{C^2 \times P \times S}{D}$

C = Diameter of Cylinder in inches.
P = Mean Effective Pressure of steam in cylinder.
S = Stroke of Piston in inches.
D = Diameter of Drivers in inches.

Tractive Power can never exceed adhesion, however, and maximum adhesion should never be considered as more than 25 per cent. of weight on the drivers. This will seldom be developed except in starting and by using sand. Where rail is dry adhesion can be safely estimated at 22½ per cent. of weight on drivers, but where frosty or wet it should not be estimated as greater than 20 per cent. Well designed locomotives will develop a tractive power equal to this rate of adhesion at 10 miles per hour velocity. Bulletin No. 1, American Railway Engineering and Maintenance of Way Association, shows the results of a

series of practical experiments and tests in connection with locomotive tractive power made by the Southern Pacific Company. In this work is shown the average mean effective pressure per square inch of cylinder in per cent. of boiler pressure for various piston speeds. Table No. 12 shows the drop in M. E. P. as piston speed increases, as shown on the curve adopted as a safe pressure for estimating tractive power in simple locomotives.

TABLE No. 12.

Mean Effective Pressure in Cylinders in per cent of Boiler Pressure for Various Piston Speeds in feet per minute.

Piston Speed, Feet.	M. E. P. %	Piston Speed, Feet.	M. E. P. %	Piston Speed, Feet.	M. E. P. %	Piston Speed, Feet.	M. E. P. %
250	85.0	500	62.0	750	43.5	1000	31.6
300	80.2	550	58.0	800	40.7	1050	29.8
350	75.5	600	54.0	850	38.0	1100	28.3
400	70.8	650	50.0	900	35.7	1150	27.0
450	66.4	700	46.5	950	33.6	1200	26.0

Below 250 feet the pressure is about the same, although there is probably a slight increase on starting.

From the table it can be seen that tractive power decreases as speed increases. This decrease in tractive power for velocities expressed in miles per hour is not the same in all locomotives and diameters of drivers. Considering tractive power as 100 per cent. at 10 miles an hour velocity, the decrease in power as velocity increases will be the same for locomotives having the same ratio of diameter of drivers to stroke. Table No. 13 shows the reduction in tractive power in some of the modern Union Pacific locomotives.

Table No. 13 is calculated from Table No. 12, the piston speed for each velocity in miles per hour being first ascertained, and the mean effective pressure in per cent. for each piston speed taken from the table. Then for the various train velocities the tractive power would vary directly with the per cent. of M. E. P.

MAXIMUM TRAIN LOAD.

Economy in operation of a railroad demands that locomotives be given the maximum load that can be hauled up the ruling gradient at a given rate of maintained speed. This rate of speed will vary with the character of the service, but should never be considered less than 10 miles per hour. The gross train load that can be hauled by a locomotive is ascertained by dividing the tractive power of the locomotive at the given rate of maintained speed by the total resistance in pounds per

TABLE No. 13.

Showing Reduction in Tractive Power of Union Pacific Freight Locomotives, the Tractive Power at 10 Miles Per Hour being Considered Equal to 1.00.

Stroke Drivers.	24″ 56″	28″ 62″	24″ 50″	28″ 56″	30″ 56″
Ratio = $\frac{S}{D}$	.429	.452	.480	.500	.536
Velocity, M. P. H.					
10	1.000	1.000	1.000	1.000	1.000
11	.988	.970	.968	.964	.962
12	.959	.941	.936	.930	.926
13	.931	.912	.904	.897	.892
14	.903	.883	.873	.867	.860
15	.876	.855	.843	.837	.828
16	.850	.827	.814	.807	.797
17	.825	.802	.787	.778	.766
18	.800	.777	.760	.749	.735
19	.776	.752	.733	.721	.704
20	.752	.726	.706	.693	.673
21	.728	.701	.680	.666	.643
22	.704	.676	.654	.639	.614
23	.680	.652	.629	.614	.589
24	.657	.629	605	.590	.565
25	.635	.606	581	.566	.542
26	.613	.584	.559	.545	.522
27	.592	.562	.538	.524	.500
28	.571	.541	.518	.504	481
29	.552	.523	.499	.486	.463
30	.534	.506	.482	.468	.446

ton of train. This gives the total tons of train, including engine and tender. Subtracting the weight of engine and tender from the gross train load gives weight of train behind locomotive.

VELOCITY GRADES.

The theory of Velocity Grades is thoroughly treated in Wellington's "Economic Theory of Railway Location." It is a well-known fact that a high velocity attained by a train in the descent of one hill assists very materially in the ascent of the next. The stored energy is sufficient to lift the train a certain distance vertically. Supposing the engine to develop enough energy to overcome all resistances except the force of gravity, this vertical distance expressed in feet is equal to .0351 times the square of the velocity of train expressed in miles per hour, and is called the velocity head. The virtual grade line would be a line passing through the points representing the velocity heads of a train above the actual grade line. The maximum actual gradient is not always

the ruling gradient of a district, as it may be so short that the velocity head will enable a train to surmount it without any great effort on the part of the locomotive, while a very long stretch of much lighter gradient may actually tax the locomotive to its full capacity. Although gradients may be introduced into a line which are in excess of the ruling gradient of the district, it is not advisable to do this to any great extent, as some unexpected circumstance might reduce the velocity head so that the train could not surmount the grade. Where it is desired to reduce the ruling gradient, and the financial conditions are such as to limit the expenditure to the minimum amount possible to perform the work, the short stretches of heavier grade are permissible, as they may be brought to the ruling grade at a later period when conditions are more favorable. In any system for ascertaining the ruling gradient, account must be taken of the decrease in tractive power as speed increases. The locomotive to be considered should be the one which has the greatest decrease in tractive power at the higher velocities. The minimum maintained speed should never be considered at a lower velocity than 10 miles per hour. The maximum safe speed is dependent on condition of track and alinement, but for conservative work it is best to assume it as not greater than 30 miles per hour.

Mr. C. D. Purdon, Chief Engineer of the St. Louis & San Francisco Railway, has presented a very practical method for constructing a virtual profile in a paper entitled, "Reduction of Grades on Railroads," read before the Engineers' Club of St. Louis. (See Journal Association of Engineering Societies, Vol. XXXI, No. 1, July, 1903.) The method suggested therein has been adopted in making up the accompanying tables showing the distances traveled in accelerating or retarding velocities on various grades, for the maximum trains that can be hauled on the given ruling grades at 10 miles per hour maintained speed.

In these tables the first two columns are self-explanatory. The other columns are obtained as follows:

Difference in Velocity Head is the difference of head in passing from one speed to the other, the total head being given in second column.

Engine Tractive Power in pounds per ton of train which can be hauled at assumed maintained velocity up the given ruling grade. As it is the maximum train that is considered, the tractive power per ton must just equal the resistance per ton. Applying the formula for total resistance, $R = 4 + \frac{V^2}{10} + 20$ times per cent. of grade, the following tractive power is found necessary for each ton of train at 10 miles velocity.

On	0.50	per	cent.	ruling	grade,	14.8 pounds.
"	0.60	"	"	"	"	16.8 "
"	0.70	"	"	"	"	18.8 "
"	0.82	"	"	"	"	21.2 "
"	1.00	"	"	"	"	24.8 "

At velocities below 10 miles per hour it is assumed that tractive power does not increase. This is probably in error, as at starting the piston speed is very low and the M. E. P. of steam in cylinder approaches more nearly the boiler pressure. The use of sand when necessary would increase the adhesion at the same time, so that a locomotive could probably start a train on a heavier grade than the table would indicate. At velocities above 10 miles per hour the tractive power per ton of train would decrease in the same proportion as given in Table No. 13. The locomotive shown in the last column of this table is the one considered in constructing the tables.

Train Resistance is from the formula $R = 4 + \frac{V^2}{130}$ and considers only the frictional and velocity resistances.

Excess Engine Tractive Power in the sixth column shows the difference between tractive power per ton of train and resistance due to friction and velocity. This difference is not always excess tractive power, although placed under that heading. In some instances at the higher velocities the resistance is greater than tractive power. This is expressed by using the minus sign before the difference shown in column 6. Where excess power is positive, it is used in overcoming grade, or in accelerating speed. Where it is negative, it acts as a retarding force on the train.

The Mean Equivalent Grade column shows the equivalent gradient for the mean excess tractive power in accelerating or retarding from one speed to the next higher or lower. For example: In the table for 0.82 per cent. ruling grade the excess tractive power is 16.40 pounds at 10 miles velocity, and 15.49 pounds at 11 miles. The average excess in accelerating from 10 to 11 miles is 15.95 pounds. This reduced to grade is equivalent to an 0.80 per cent. grade. Where engine tractive power is in excess of resistance the equivalent gradient is a minus or accelerating grade. Where resistance is in excess, the equivalent gradient is positive or a retarding grade.

In order to find the distance traveled in passing from one speed to the next rate given in the table, divide the tabular difference in velocity heads by the algebraic sum of the actual rate of grade and the mean equivalent gradient. The quotient gives the distance in stations. In the table under each rate of actual gradient are two columns: The first, headed "Distance," gives the distance in passing from one velocity to the next for that rate of actual gradient. The second gives the total distances in raising velocity from the initial speed that is used in the table. It will be noted that on any gradient velocity can be accelerated only to the point where the sum of the equivalent gradient and the actual gradient is zero, or, expressed more clearly, to the point where the accelerating and retarding forces become equal. Velocities above this point will meet with retarding forces. In the tables the distances below the heavy lines are distances traveled in retarding velocities, the total distances being the sum of the distances in retarding from 30 miles per hour.

To obtain the distance traveled in accelerating or retarding speed from one velocity to any other velocity on a given grade, take the

difference between the distances given in the total distance column. Having the initial velocity and the length of grade, to find the velocity head for terminal velocity, add the length of grade to total distance, and the result will be the corresponding total distance for terminal velocity, if within the limits of the table. In using this rule, however, the engineer must not overlook the fact that there is a point where the speed will remain constant and this point may be reached before the end of the grade under consideration.

Tables can be constructed for other grades as desired. The tables can be platted in diagram form, but should be on such a scale that there will be no interfering of the lines on the chart. Intermediate velocity heads for given length grades can be interpolated if desired.

The accompanying profile shows the method to be used in platting a virtual grade. The actual maximum grade is 1.50 per cent. It is desired to see if it can be operated as an 0.82 per cent. grade for trains passing from the right to the left. First a table is prepared showing the length of each grade. In the example a line has been assumed with no curvature; in practice the curve resistance should be added to the actual grade. Considering curve resistance as 0.04 per cent. per degree of curve, a 3-degree curve, 1,200 feet long, on a 0.6 per cent. grade, should be considered equal to a grade of 0.72 per cent. for 1,200 feet, on ascending grades, and as a 0.48 per cent. grade for 1,200 feet on descending grades, the 3-degree curve being equivalent to a 0.12 per cent. retarding grade.

Table of Data in Connection with Profile.

Station to Station.		Distance Stations.	Actual Grade.	Velocity Head.	REMARKS.
0	5	5.00	0.0	3.5	
5	27	22.00	—1.0	31.0	
27	32	5.00	0.0	30.7	
32	64	32.00	+1.25	3.5	
64	66	2.00	0.0	5.0	
66	91	25.00	—0.82	31.2	
91	95	5.00	0.0	31.0	
95	205	110.00	+0.82	3.5	
205	207	2.00	0.0	5.0	
207	231	24.00	—1.50	31.6	Steam shut off.
231	236	5.00	0.0	31.3	
236	261	25.00	+1.50	3.5	
261	281	20.00	+0.82	3.5	
281	283	2.00	0.0	5.0	
283	319	36.00	—1.50	31.6	Steam shut off Brakes applied Station 307.
319	324	5.00	0.0	31.3	
324	349	25.00	+1.25	7.9	
349	389	40.00	+0.82	4.7	

Having filled the first four columns of the table from the profile, the velocity heads are obtained from the tables. Starting at Station "0," it is seen that a train can attain 3.5 feet velocity head, or 10-mile velocity on a level in 424 feet. Velocity head at Station 5 will be

3.5 feet. The next stretch is 2,200 feet of —1.0 grade. Total distance in the —1.0 column for 10 miles equals 1.93 stations. Adding 22 stations to this gives 23.93 stations, which is equivalent to a velocity of nearly 30 miles per hour. Interpolating, the velocity head is found to be about 31 feet, which is set down in table. The next stretch is five stations of level. It can be seen from the table that the train cannot accelerate much above 28 miles per hour on a level. Therefore, in this case it is a retarding force. Interpolating for total distance for 31 feet velocity head for level, 12 stations is obtained as result. Adding the 5 stations of level gives a total distance of 17 stations, or a velocity head 30.7 feet.

Proceed in the same manner with all the grades on profile. On the stretch of accelerating grade from Stations 207 to 231, it will be found that with steam working the train will attain the 30-mile maximum speed in about 1,500 feet and it would be necessary to apply brakes to hold the train from exceeding this limit. In practice, steam should be shut off after rounding the summit and gravity be depended on for acceleration. So far as virtual grade is concerned, the method adopted in practice will make no difference, provided the same velocity is attained at the foot of the grade. The table showing velocity heads and distances traveled with steam shut off can be referred to in order to see at what point steam can be shut off and the necessary velocity head attained.

On the stretch of accelerating grade from Station 283 to 319, even with steam shut off, it will be necessary to apply brakes in order to hold within the 30-mile per hour velocity.

After having ascertained the velocity heads at the various points, these can be set off on the profile above the actual grade line, and the line connecting the points will be the average virtual grade for each section considered. The true virtual grade would be in a curved line on accelerating and retarding stretches, but on a profile where the ruling gradient has been fixed, no point in the virtual grade line will be nearer the actual grade than the velocity head for the assumed maintained speed, except near stopping points. On the profile used for illustration, had the 1.50 per cent. grade been extended beyond Station 261 it would have been necessary to change the actual grade and keep it at least 3.5 feet below the virtual grade line in order to operate as an 0.82 per cent. controlling grade at 10 miles maintained velocity. This illustration shows how a line with an actual 1.50 per cent. grade may be operated by a train loaded for 0.82 per cent. ruling grade, but should there be any need of checking the speed so as to fall below the velocity head shown on the profile at the foot or at any point on the adverse grades, the train would not be able to make the hill in the manner calculated, and would in all probability be stalled. Therefore, in revising grades, it is better to reduce the actual gradient so far as possible to the ruling grade, or at least to reduce or shorten the excess grades with a view to entire elimination at some future time.

In the tables giving the distances traveled in accelerating speed, only even or whole miles are considered. Acceleration should be cal-

culated to the exact point where speed could be maintained, but this is an unnecessary refinement. As has been shown in preceding pages, resistances may not be just the same, and the mean effective pressure for the various velocities may vary in different locomotive cylinders, depending largely on the manner in which the engineer handles his engine. So, for practical purposes, the tables are sufficiently close, and any interpolation can be approximated mentally.

These tables are constructed solely to show the distance traveled in accelerating or retarding speed to the point where the velocity would remain constant, provided the boiler could furnish the necessary steam. It must not be presumed that the higher velocities could be maintained indefinitely, since large quantities of steam would be required by the ordinary freight locomotive at these high velocities. There is little question, however, of the boilers being able to furnish the necessary steam for the short time required to accelerate to the velocities given in the table, and this is all that is required for use at points where necessary to construct a virtual profile.

SUMMARY.

Before beginning work on a new location the Chief Engineer will indicate the character of the proposed line, probable volume of traffic expressed in tons and trains per day, and the size and tractive power of the locomotive to be used.

For the field engineer the following approximate formulas are introduced and the values given for reduction in gradient, distance, curvature and rise and fall.

For general purposes the tractive power of a locomotive can be considered at 20 per cent. of the weight on drivers at a velocity of 10 or 12 miles per hour, although with fair weather conditions a well-designed locomotive should develop a tractive power of 22½ per cent. of the weight on drivers at 10 miles per hour.

Assuming 6 pounds per ton velocity and frictional resistances as a fair average for slow and fast freights, with grade resistance 20 times the rate per cent. of grade:

$$\text{Tons weight of train, including engine and tender} = \frac{\text{Tractive Power}}{6 + 20\ (\%\ \text{grade})}$$

In using this formula for estimating the number of trains necessary to handle the tonnage, the weight of freight may be considered as 50 per cent. of the weight of train exclusive of the locomotive.

GRADIENTS.—A reduction of gradient on an engine district 100 miles long so as to require one less daily train in each direction will result in a saving of $37,230.00 per annum.

For other lengths of district, or a greater reduction in the required number of trains, the saving in operating expenses per annum will be in direct proportion to this.

Any reduction in length of helper grades, or other change that will eliminate one helper engine of the same size as the standard road engine,

will result in a saving of $14,673.00 per annum, providing the helper engines average 100 miles per day. For other average daily mileage of helper the saving can be estimated as directly proportional to this.

DISTANCE.—A saving in distance will result in the following savings per annum per daily train one way:

Class "A"—Distances so short as not to affect wages of engine or train men.

2.6 cents per foot, or $137.00 per mile.

Class "B"—Distances affecting train wages, but not affecting the number of side tracks required.

3.7 cents per foot, or $196.00 per mile.

Class"C"—Distances so great as to affect the number of side tracks required.

4.8 cents per foot, or $252.00 per mile.

CURVATURE.—The elimination of one degree of curvature will result in a saving per annum per daily train one way:

Uncompensated Curvature, 23 cents per degree.
Compensated Curvature, 19 1-3 cents per degree.

RISE AND FALL.—The elimination of one foot rise and fall will result in a saving per annum per daily train one way as follows:

Class "B"—Where grades are such as to require shutting off steam in descending but not to require the application of brakes:

On Minor Grade, $0.55 per foot.
On Ruling Grades, $0.96 per foot.

Class "C"—Where grades are so heavy as to require the application of brakes:

On Minor Grade, $1.15 per foot.
On Ruling Grades, $1.57 per foot.

These values are sufficiently close for the locating engineer to use in comparing the various lines, a final and more careful comparison to be made in the office of the Chief Engineer.

TABLE OF DISTANCES.

(Accelerations)

—0.6% to —1.50% Grades.

Locomotive Drifting.

UNION PACIFIC RAILROAD.

Table showing acceleration of Trains on descending grades, with steam shut off, for velocities from 10 to 30 miles per hour

Velocity Miles per Hour	Train Resistance. Lbs	Difference in Velocity Head.	Mean Equivalent Grade.	−0.6 GRADE		−0.7 GRADE.		−0.8 GRADE		−0.9 GRADE.		−1.00 GRADE.		−1.25 GRADE.		−1.50 GRADE	
				Distance.	Total Distance.	Distance.	Total Distance.	Distance.	Total Distance.	Distance.	Total Distance.	Distance.	Total Distance.	Distance.	Total Distance.	Distance.	Total Distance.
10	4.8																
11	4.9	0.74	+0.24	2.06	2.06	1.61	1.61	1.32	1.32	1.12	1.12	0.97	0.97	0.73	0.73	0.60	0.60
12	5.1	0.81	+0.25	2.31	4.37	1.80	3.41	1.47	2.79	1.25	2.37	1.08	2.05	0.81	1 54	0.65	1.25
13	5.3	0.87	+0.26	2.56	6.93	1.98	5.39	1.61	4.40	1.36	3.73	1.18	3.23	0.88	2 42	0.70	1.95
14	5.5	0.95	+0.27	2.88	9.81	2.21	7.60	1 79	6.19	1.51	5.24	1.30	4.53	0.97	3.39	0.77	2.72
15	5.7	1.02	+0.28	3.19	13.00	2.43	10.03	1.96	8.15	1.65	6.89	1.42	5.95	1.05	4.44	0.84	3 56
16	6.0	1.09	+0.29	3.52	16.52	2.61	12.64	2 14	10.29	1.79	8.68	1.54	7.49	1.14	5.58	0.90	4.46
17	6.2	1.16	+0.31	4.00	20.52	2.97	15.61	2.37	12.66	1.97	10.65	1.68	9.17	1.23	6.81	0.97	5.43
18	6.5	1.23	+0.32	4.39	24.91	3.24	18.85	2.56	15.22	2 12	12 77	1.81	10.98	1.32	8.13	1.04	6.47
19	6.8	1.30	+0.33	4.81	29.72	3.51	22.36	2.77	17.99	2 28	15.05	1.94	12.92	1.41	9 54	1.11	7.58
20	7.1	1.37	+0.35	5.48	35.20	3.91	26.27	3.04	21.03	2.49	17.54	2 11	15.03	1.52	11.06	1.19	8.77
21	7.4	1.44	+0.36	6.00	41.20	4.24	30.51	3.27	24.30	2.67	20.21	2.25	17 28	1.62	12 68	1 26	10.03
22	7.7	1.51	+0 38	6 86	18 06	4.72	35.23	3 60	27.90	2.90	23.11	2.44	19.72	1.74	14.42	1.35	11.38
23	8.0	1.58	+0.39	7.52	55.58	5.10	40 33	3.85	31.75	3.10	26.21	2.59	22.31	1.84	16.26	1.42	12.80
24	8.4	1.65	+0.41	8.68	64.26	5.69	46 02	4 23	35.98	3.37	29.58	2.80	25.11	1.96	18.22	1.51	14.31
25	8.8	1.72	+0.43	10.12	74.38	6.37	52.39	4 65	40.63	3.66	33.24	3.02	28.13	2.10	20.32	1.61	15.92
26	9 2	1.79	+0.45	11.93	86.31	7.16	59.55	5.11	45 74	3.98	37.22	3.25	31.38	2.24	22.56	1.70	17.62
27	9.6	1.86	+0.47	14.31	100.62	8.09	67.64	5.64	51.38	4.32	41.54	3.51	34.89	2.38	24.94	1.81	19.43
28	10.0	1.93	+0.49	17.55	118.17	9.19	76.83	6.23	57.61	4.71	46.25	3.78	38.67	2.54	27.48	1.91	21.34
29	10.5	2.00	+0.51	22.22	140.39	10.53	87.36	6.90	64.51	5.13	51.38	4.08	42.75	2.70	30.18	2.02	23.36
30	10.9	2.07	+0.53	29.57	169.96	12.18	99.54	7.67	72.18	5.59	56 97	4 40	47.15	2.87	33.05	2.13	25.49

TABLE OF DISTANCES.

(Accelerations and Retardations)

0.0% to +1.50% Grades.

Locomotive under Full Throttle.

UNION PACIFIC RAILROAD

Table showing Distance traveled in accelerating speed on various Gradients, of a Locomotive loaded with the maximum [illegible]

Figures below heavy lines show retarding of speed to the point where [illegible]

DISTANCES ARE EXPRESSED IN STATIONS OF 100 FEET

Velocity in Miles per Hour	Velocity in Feet	Difference in Velocity in Feet	Tractive Power Lbs. per Ton	Train Resistance Lbs. per Ton.	Excess Engine Tractive Power Lbs. per Ton.	Mean Accelerating Grade.	0.0 GRADE		+0.10 GRADE		+0.20 GRADE		+0.30 GRADE		+0.40 GRADE		+0.50 GRADE		+0.60 GRADE		+0.70 GRADE		+0.80 GRADE		+0.90 GRADE		+1.00 GRADE		+1.10 GRADE		+1.20 GRADE	
							Distance	Total Distance	Distance	Total Distance	Distance	Total Distance	Distance	Total Distance	Distance	Total Distance	Distance	Total Distance	Distance	Total Distance	Distance	Total Distance	Distance	Total Distance	Distance	Total Distance	Distance	Total Distance	Distance	Total Distance	Distance	Total Distance
0	0.00	..	21.20	18.0	3.20	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1	0.04	0.04	21.20	8.0	13.20	−0.41	0.09	0.09	0.13	0.13	0.19	0.19	0.37	0.37	4.00	4.00																
2	0.14	0.10	21.20	6.0	15.20	−0.71	0.14	0.23	0.16	0.29	0.20	0.39	0.24	0.61	0.32	4.32																
3	0.32	0.18	21.20	5.3	15.90	−0.78	0.23	0.46	0.26	0.55	0.31	0.70	0.37	0.98	0.47	4.79																
4	0.56	0.24	21.20	4.8	16.40	−0.81	0.29	0.75	0.34	0.89	0.39	1.09	0.47	1.45	0.59	5.38																
5	0.88	0.32	21.20	4.5	16.70	−0.83	0.38	1.13	0.44	1.33	0.51	1.60	0.60	2.05	0.74	6.12																
6	1.26	0.38	21.20	4.4	16.80	−0.84	0.45	1.58	0.51	1.84	0.60	2.20	0.71	2.75	0.86	6.98																
7	1.72	0.46	21.20	4.4	16.80	−0.84	0.54	2.12	0.62	2.46	0.72	2.62	0.85	3.60	1.05	8.03																
8	2.25	0.53	21.20	4.5	16.70	−0.84	0.63	2.75	0.72	3.18	0.83	3.75	0.98	4.58	1.20	9.23																
9	2.85	0.60	21.20	4.6	16.60	0.83	0.72	3.47	0.82	4.00	0.95	4.70	1.13	5.71	1.39	10.62																
10	3.51	0.66	21.20	4.8	16.40	−0.82	0.81	4.28	0.92	4.92	1.06	5.76	1.27	6.98	1.57	12.19																
11	4.25	0.74	20.39	4.9	15.49	−0.80	0.92	5.20	1.06	5.98	1.23	6.99	1.48	8.46	1.85	14.04	2.47	2.47	3.70	3.70	7.40	7.40	37.00	110.98	4.0	02.58	3.70	4.[illegible]	1.04	31.78	1.06	24.45
12	5.06	0.81	19.63	5.1	14.53	−0.75	1.08	6.28	1.25	7.23	1.47	8.46	1.80	10.26	2.31	16.35	3.24	5.71	5.40	9.10	16.20	23.60	11.57	73.98	5.40	[illegible]	3.24	[illegible]	1.02	[illegible]	1.08	23.29
13	5.93	0.87	18.91	5.3	13.61	−0.70	1.24	7.52	1.45	8.68	1.74	10.20	2.17	12.43	2.90	19.25	4.35	10.06	8.70	17.80			7.25	62.41	4.35	[illegible]	2.90	40.62	1.58	28.52	1.06	22.21
14	6.88	0.95	18.24	5.5	12.74	−0.66	1.44	8.96	1.70	10.38	2.06	12.26	2.64	15.07	3.65	22.90	5.94	16.00	15.83	33.63	23.75	96.72	5.94	[illegible]	[illegible]	[illegible]	2.79	37.72	1.64	20.94	1.13	21.12
15	7.90	1.02	17.55	5.7	11.85	−0.61	1.67	10.63	2.00	12.38	2.49	14.75	3.29	18.36	4.86	27.76	9.27	25.27	102.00	135.63	11.33	72.07	4.86	19.22	3.52	11.17	2.02	31.93	1.50	25.33	1.15	19.99
16	8.99	1.09	16.90	6.0	10.90	−0.57	1.91	12.54	2.32	14.70	2.95	17.70	4.04	22.40	6.41	34.17	15.57	40.84	9.76	114.95	8.38	61.64	4.32	14.36	3.30	37.95	2.53	[illegible]	1.40	23.74	1.17	18.84
17	10.15	1.16	16.24	6.2	10.04	−0.52	2.23	14.77	2.76	17.46	3.62	21.32	5.27	27.67	9.67	43.84	58.00	[illegible]	14.50	78.65	6.44	53.26	3.87	40.04	[illegible]	[illegible]	2.42	20.78	1.79	22.14	1.18	17.67
18	11.38	1.23	15.58	6.5	9.08	−0.48	2.56	17.33	3.24	20.70	4.39	25.71	6.83	34.50	15.37	59.21	61.50	147.71	10.25	64.12	5.59	46.82	3.62	[illegible]	2.93	[illegible]	2.37	27.36	1.59	20.55	1.24	16.40
19	12.68	1.30	14.92	6.8	8.12	−0.43	3.02	21.35	3.94	24.64	5.65	31.36	10.00	44.50	43.33	102.54	18.57	83.81	7.65	53.87	4.81	41.23	[illegible]	32.55	2.76	28.67	2.28	24.99	1.38	18.00	1.21	15.29
20	14.05	1.37	14.27	7.1	7.17	−0.38	3.61	25.96	4.89	29.53	7.61	38.07	17.12	61.62	68.50	158.69	11.42	65.24	6.23	46.22	4.28	36.42	3.11	20.22	2.63	[illegible]	2.21	22.71	1.58	17.38	1.22	14.08
21	15.49	1.44	13.63	7.4	6.23	−0.34	4.24	28.20	6.00	35.53	10.28	49.25	[illegible]	[illegible]	24.60	80.19	9.00	53.82	5.54	39.90	4.00	32.14	3.60	20.11	2.57	[illegible]	2.18	20.60	1.58	15.80	1.24	12.83
22	17.00	1.51	13.02	7.7	5.32	−0.29	5.21	33.41	7.95	43.48	16.78	66.03	151.00	248.41	13.73	66.19	7.24	44.82	4.90	34.45	3.71	28.14	2.85	23.11	2.49	20.71	2.14	18.32	1.58	14.22	1.25	11.62
23	18.58	1.58	12.49	8.0	4.49	−0.25	6.32	39.73	10.53	54.01	31.60	97.63	31.60	97.41	10.53	52.46	6.32	37.58	4.51	29.55	3.51	24.43	2.77	20.26	2.43	18.22	2.11	16.18	1.58	12.64	1.26	10.37
24	20.23	1.65	11.98	8.4	3.58	−0.20	8.25	47.98	16.59	70.51			16.50	65.81	8.25	41.93	5.59	31.26	4.12	25.04	3.30	20.92	2.66	17.49	2.36	15.70	2.07	14.07	1.57	11.06	1.27	9.14
25	21.95	1.72	11.49	8.8	2.69	−0.16	10.75	58.73	28.67	99.18	43.09	107.36	12.29	49.31	7.17	33.68	5.06	25.76	3.91	20.92	3.18	[illegible]	[illegible]	14.83	[illegible]	13.43	2.05	12.00	[illegible]	9.49	1.28	7.84
26	23.74	1.79	11.07	9.2	1.87	−0.11	16.25	74.98	179.81	278.18	19.89	64.36	9.42	35.02	6.17	26.51	4.59	20.70	3.65	17.01	3.03	14.44	[illegible]	12.23	2.27	11.11	2.01	9.95	1.57	7.91	1.29	6.50
27	25.60	1.86	10.60	9.6	1.00	−0.07	26.57	101.55	62.00	121.[illegible]	14.31	44.47	8.09	27.69	5.64	20.34	4.32	16.11	3.51	13.36	2.95	11.41	2.48	9.71	2.24	8.84	2.00	7.94	[illegible]	[illegible]	1.30	5.27
28	27.53	1.93	10.20	10.0	0.20	0.03	65.43	167.88	27.57	59.55	11.35	30.16	7.15	19.51	5.22	14.70	4.11	11.79	3.39	9.85	2.88	8.46	2.44	7.23	2.22	6.60	1.99	[illegible]	1.58	4.76	1.31	3.97
29	29.53	2.00	9.81	10.5	−0.69	+0.01	240.60	241.40	18.18	31.98	10.53	18.81	6.45	12.36	4.88	9.48	3.92	[illegible]	3.28	6.46	2.82	5.58	[illegible]	4.70	2.20	4.38	[illegible]	3.95	[illegible]	3.18	1.32	2.66
30	31.60	2.07	9.46	10.9	−1.44	+0.05	41.40	41.40	13.80	13.80	8.28	8.28	5.91	5.91	4.60	4.60	3.76	3.76	[illegible]	3.18	2.76	2.76	2.38	2.38	2.18	2.18	[illegible]	1.97	[illegible]	1.59	1.34	1.34

TABLE OF DISTANCES.

(Accelerations and Retardations)

0.0% to —1.50% Grades.

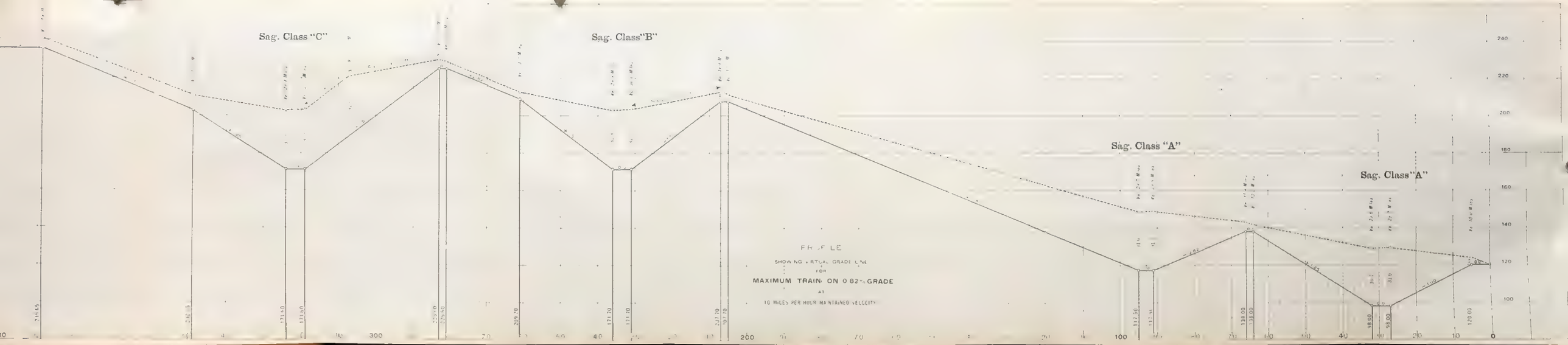
Locomotive under Full Throttle.

| | | |

VIRTUAL PROFILE

SHOWING

SAGS OF CLASSES "A," "B" AND "C."


Sag. Class "C"
Sag. Class"B"
Sag. Class "A"
Sag. Class"A"
MAXIMUM TRAIN ON 0.82% GRADE
AT
10 MILES PER HOUR MAINTAINED VELOCITY

DISCUSSION.

Mr. W. F. Tye (Canadian Pacific) :—The Committee on Roadway wishes to say that it has unintentionally omitted or misstated something. Its conclusion No. 2 reads: "A threefold classification of materials: Solid Rock, Loose Rock, and Common Excavation, as herein described." Members will recollect that that is the way it was presented last year, but it was amended to read: "A threefold classification of materials, viz., Solid Rock, Loose Rock, and Common Excavation, as herein described, and in special cases such additional classification of material as may seem necessary; such additional class to be distinctly defined and specified in the contract." It should be stated in that way and we wish it printed that way.

If it is in order we would like to have Section 91 amended. It now reads, "In the foregoing specifications it is understood that it is the Engineer or Chief Engineer whose judgment, direction, decision, approval, etc., are referred to whenever such terms are used." I may say that we have decided, in order to condense the specifications, to cut out, wherever possible, every reference to the direction, decision, approval, etc., of the Engineer, and in order to cover such omission we have inserted the clause No. 91. We would, however, like to have it amended to read as follows: "In the foregoing specifications it is understood that it is the Engineer or Chief Engineer whose judgment, direction, decision, approval, etc., are to be accepted, whether such terms are actually used or not."

(Alterations adopted.)

Mr. Duncan MacPherson (Canadian Pacific—by letter) :—I would submit the following remarks on report of Committee on Roadway:

Clause 4 of Specifications for Construction of Roadway gives width of 20 feet at subgrade for banks and excavations. This width may be necessary in cuttings, where it is desirable to keep water away from the roadbed, but appears waste of money in high banks, when, with the recommended depth of 12 inches of ballast under 8-ft. ties, shoulder of 12 in. and slopes 1½ to 1, the base width of ballast is only about 15 feet. This leaves a berme of about 2½ feet on each side. What useful purpose is served by this, which would not be equally well served by a berme of 1½ ft. or roadbed of 18 ft.?

Definitions: I would suggest the following changes in proposed definitions:—

Drainage.—The interception and removal of water from above or under the roadway, instead of "The removal or interception," etc.

Gradient.—The rate of ascent or descent of the horizontal plane of the roadway, instead of the "rate of ascent, etc., of the center line." (This

change seems necessary, in order that definition for profile may be consistent.)

ROCK.—Insert the words "or kindred," so that it would read, "a large, hard mass of mineral, or kindred substance." (A good many rocks contain minerals, but are all rocks necessarily minerals?)

TRENCH.—A ditch or excavation to provide for drainage, or for the construction of foundation, etc., instead of "A ditch for providing drainage."

DISCUSSION ON THE ECONOMICS OF REVISION WORK.

Mr. Lewis Kingman (Mexican Central—by letter) :—I have received Bulletin No. 49, and am much interested in Mr. Berry's article on the changes recently made on the Union Pacific Railroad.

First, in Table No. 1, giving the cost of a train mile on the Union Pacific Railroad as $1.17. This table gives the operating expenses, but does not give any charges for interest account.

The Mexican Central Railway train service per kilometer has cost, including interest and deficit account, for the last four years, as follows:

	Items of cost in an average train kilometer—	Mexican Silver. 1899. Cents.	1900. Cents.	1901. Cents.	1902. Cents.
1.	Superintendence, transportation....	1.00	1.15	1.13	1.355
2.	Superintendence, traffic	0.56	0.54	0.53	0.558
3.	Maintenance of way and structures.	18.35	19.78	18.10	23.166
4.	Maintenance of equipment	16.66	20.60	22.80	26.234
5.	Fuel	22.69	28.72	29.73	30.355
6.	Use of engines and cars.....	5.00	5.00	5.00	5.000
7.	Train crews	4.23	4.32	4.13	5.015
8.	Engineers and firemen.....	6.96	7.07	6.95	7.942
9.	Oil and waste.....	0.64	0.71	0.67	0.956
10.	Train supplies	0.92	0.96	1.11	1.510
11.	Water stations	1.32	1.20	1.51	1.396
12.	Station service	7.17	6.83	7.10	8.251
13.	Telegraph service	0.69	0.72	0.72	0.791
14.	Wrecking expenses	0.39	0.57	0.51	0.561
15.	Floating equipment	0.27	0.31	0.22	0.272
16.	Advertising	0.28	0.30	0.25	0.316
17.	Stationery and printing, transportation department	0.75	0.64	0.85	0.959
18.	Car mileage balance	1.81	1.94	1.55	1.451
19.	Loss and damage to property.....	1.09	1.21	1.31	1.343
20.	Revenue stamps	1.29	1.72	1.46	1.839
21.	Duties on material imported	....	....	1.17	1.279
22.	Foreign agencies	1.24	1.26	1.10	1.122
23.	Customs agencies	0.55	0.50	0.52	0.526
24.	Rental of buildings	0.04	0.06	0.07	0.089
25.	General expenses	5.94	7.29	6.87	8.216
26.	Interest account	40.55	44.01	39.04	44.318
27.	Deficit account	....	....	6.83	9.740
	Total cost per kilometer.....	$1.4039	$1.5741	$1.6123	$1.8456

In 1899 a Mexican silver dollar averaged 48.41 cents in United States gold; exchange averaged $2.06½, which would have made a train kilometer on the Mexican Central cost 68 cents per kilometer, or $1.097 per mile. This includes 40.55 cents per kilometer interest account, or 19.6 cents gold per kilometer, or 31.6 cents gold per mile, which, deducted

from $1.097, the cost per train mile, would leave 78.1 cents gold, the cost of operating expenses, on the Mexican Central for 1899. Figuring in the same way, the cost of operating expenses in 1900, with exchange averaging $2.04 4-10, would be 89 cents gold per train mile. In 1901, operating expenses, with exchange averaging at $2.091, would be 88.8 cents gold per train mile. In 1902, exchange at $2.372, operating expenses would be 88.7 cents gold per train mile.

When it is considered that the Mexican Central Railway paid for fuel as follows:

1899,	Mex.	Silver,	$0.2269	per	Kil.,	or	17.7	cts.	Gold	per Mile.
1900,	"	"	0.2872	"	"	"	22.7	"	"	"
1901,	"	"	0.2973	"	"	"	22.9	"	"	"
1902,	"	"	0.3035	"	"	"	20.6	"	"	"

the Mexican Central averaged 20.97 cents gold per mile for fuel during these four years, or nearly twice as much as the Union Pacific, yet the Mexican Central during these four years operated their trains for 30.9 cents gold per mile cheaper than the Union Pacific Railroad did.

In looking over Table No. 1, and then reading Mr. Berry's comments on page 8, it would seem that Table No. 1 is made up of arbitrary percentages, deduced from the report of the Interstate Commerce Commission, Wellington & Webb's work on Location and Construction, and not on actual conditions on the Union Pacific Railroad.

Nearly every road has its own way of making up train mileage. The Mexican Central includes all trains and all engines running on the main line and branches in their mileage report, but does not include switch engines in the yards or at the division points. An engine out on the road has its engineer, fireman, conductor and usually a full train crew. The engine causes more wear and tear on the track than the balance of the train; water, fuel, telegraph and station service cost nearly as much as the loaded train. For these reasons I do not see why the engine mileage should not be included with the train miles.

On locating it is often necessary, when comparing alternate lines, to consider interest account. On the Central one-fourth of the cost of moving trains is the charge to capital account. On some of the roads of this country it is nearly one-half the cost of moving trains.

In Table 9, page 18, I do not agree with Mr. Berry in the proportions allowed in Columns A, B and C. Class "A," distances so short as not to affect train wages; train men should be paid in proportion for what they do. Sooner or later they are sure to get it.

Class "B," distances affecting train wages, but not stations or sidings; stations and sidings bear a very small proportion to the cost of a train mile.

Class "C." I do not see why this class should not be the average cost of train mileage for the whole line. Fuel, equipment, renewals, and nearly all expenses are in proportion to the miles run.

Mr. Berry speaks of some particularly dangerous curves, but does

not explain why they are dangerous. Mr. Berry takes a 12 degree 30 minute curve as an example of a curve which he shows to be worth 19.3 cents per daily train per annum. Allowing ten trains per day, a degree of a 12 degree 30 minute curve would have a negative value of $1.93. It would be interesting to know how much he would value one degree of a 2-degree curve. Most all American engineers have learned Wellington's theories in regard to curvature, and they do not think for themselves.

Wellington said on page 641, article 858, "Sharp curves lengthen short tangents, . . . an advantage." On page 640 he makes a thoughtful practical roadmaster admit that a 5-degree curve was cheaper to maintain than a 10-degree curve. Wellington believed that the wear and tear on rail and rolling stock was the same per degree, whether on light or sharp curves, and that sharp curves were not dangerous. When Wellington started in on a theory, he would prove it or die in the attempt. He proved his theory of momentum grades, and he has taught locating engineers the free use of curvature, until it is hard to get a man in charge of a locating party to use light curvature. They say, "Let us use a good curve and get onto a tangent and done with it. Give us long tangents and short curves." Often they would use a 4-degree curve when a 1-degree would be as cheap and considerably shorter. Wellington's teachings on curvature have been pernicious and expensive.

The Mexican Central has one mountain division 26.7 kilometers long with a total curvature of 7,504 degrees. The maximum curve is 14 degrees 37 minutes. There are 74 curves of 12 degrees and over, having 4,573 degrees of curvature. We have one kilometer, 3,280 feet of track with 534 degrees of curvature. This is at the rate of 861 degrees to the mile.

I make this statement to show that we have had some experience with curvature, and have reason for not liking too much of it. The following table was made in 1900 and has been used by locating engineers, and they are instructed to use these negative values in throwing out curvature. These values are figured for twelve trains each way or 24 trains over the line, and instructions to increase or diminish the values in proportion to the number of trains. All of our curves are measured by a 20 meter chord, and our degrees of curve are one and a half times those subtended by a 100 ft. chord, about. Thus, a 6-degree curve measured by a 20 meter chord is equal to a 9-degree curve measured by a 100 ft. chord.

These values are used in comparing alternate lines, and show the engineer how much he can spend in reducing a heavy curve to a lighter one.

For convenience of the locating engineers in the field, this table is extended, giving values of every five minutes up to 12 degrees 30 minutes. These tables of curve value have been used for the last five years, during which time we have had from two to thirteen locating parties in the field.

Degree of Curve. Degrees.	Minutes.	Value of one degree.	Degree of Curve. Degrees.	Minutes.	Value of one degree.
0	30	$ 0.75	8	00	$ 49.50
1	00	2.25	8	30	54.75
1	30	4.00	9	00	60.25
2	00	6.00	9	30	66.00
2	30	8.25	10	00	72.00
3	00	10.75	10	30	78.25
3	30	13.50	11	00	84.75
4	00	16.50	11	30	91.50
4	30	19.75	12	00	98.50
5	00	23.25	12	30	105.75
5	30	27.00	13	00	113.25
6	00	31.00	13	30	121.00
6	30	35.25	14	00	129.00
7	00	39.75	14	30	137.25
7	30	44.50	15	00	145.75

This table of curve values is one of my own. It is the result of years of experience. I have located many miles of railway. I know that railways are dangerous. Every bridge, every curve, every tunnel, and every man, rail and tie in a railway has an element of danger. It is only by eternal vigilance that the line is kept open and in perfect condition.

The values of curves in this table were determined by our experience on the Tamasopo Mountain, between Las Canoeas and Tamasopo, a distance of 26.7 kilometers, previously mentioned.

We laid 66 lb. steel in May, 1897, and within 18 months the rails on the sharp curves had to be removed and exchanged for those on tangents. One kilometer of the 14 degree 30 minute curve would have 1,087 degrees 30 minutes.

We have the following items chargeable to curvature, on one kilometer of this 14 degree 30 minute curve, measured by 20 meter chords:

The steel rail only lasts 18 months. It is not worth one-half first cost, and is only suitable for sidetracks. Often worn on both sides until the head of rail is not more than 1 inch wide. 64.43 tons at half cost, $33.00	$ 2,126.19
Then allowing the equipment is worn as much as the rail	2,126.19
Tieplates, 3,280. These tieplates would have lasted four years if on tangent. They did not last 1 year on this curve. 3,280 tieplates at $0.12	393.60
Ties, 1,640. These cost $2.00 each. They were worth 50c for sidetracks at the end of 18 months. They would have lasted four years on tangent	1,230.00
Labor account, increased by curve maintenance of track, 15 cents per train per kilometer, for 18 months	1,971.00
Cost of taking up and relaying track, in excess of what it would cost to maintain for 18 months, $100.00 per kilometer for taking up, and $400.00 per kilometer for relaying	340.02
Wrecking expenses, allowing there are ten times as many as average on whole line, 24 trains per day, at .0056 cent for 18 months	734.16
Loss and damage to property, allowing ten times average on whole line, 24 trains per day, at .0134 cent	1,756.74
Loss to human life on account of curvature	800.00
Total wear and tear loss due to curve	$11,477.90
As this is for 18 months, one year would be	7,651.93

On a system of railways, in a mountainous country like Mexico, locating engineers must have some definite instructions as to the value of ruling grades, rise and fall, distance and curvature. Without these values, an engineer is apt to go to extremes and imagine a bend in the line particularly dangerous, and spend more work than necessary.

As there are 1,087 degrees 30 minutes in the kilometer under consideration, this would give $7,036 per degree, which, capitalized at 5 per cent., would give $140.72, the value of one degree in a 14 degree 30 minute curve.

After determining the negative value of one degree in a 14-degree 30 minute curve, I adjusted the values from a 30 minute curve to a 15 degree curve, using my judgment in the matter. The values do not increase very fast with light curves.

I hope that these notes on curvature will lead to further investigation, and that engineers will treat the subject as one of the very important questions on location.

MR. J. B. BERRY (Union Pacific—by letter):—Referring to discussion by Mr. Kingman, I fail to see why interest charges should be considered in making up the cost per train mile. The only way that interest charges should be considered is in the manner mentioned in the first paragraph under the heading "Economic Basis of Revision Work," on page 6 of Bulletin No. 49.

I have not time to reduce the costs per train kilometer on the Mexican Central Railway to costs per train mile in gold for the various items, but should Mr. Kingman take the time to do this he will find that, although the fuel may not cost more per train mile than on the Union Pacific Railroad, those items which have a large amount of labor entering into the question will show up much less per train mile, and the true explanation of the difference in cost per train mile would appear.

Table No. 1 of the Bulletin is exactly what its heading indicates, and the percentages were deduced from the actual charges to the various items for the four years; but this matter is irrelevant, as the Bulletin was not prepared to make comparison between the cost per train mile on Union Pacific and any other railroad.

While the system of making up train mileage may differ, if Mr. Kingman will carefully study the paper he will note that this variation has been taken into consideration and that in deducing values of the different details of such items as engine and roundhouse men, repairs and renewals of locomotives, locomotive fuel, etc., the proportions affected are taken as indicated in Tables 2 and 4, using only that portion of each item that would be used by the engines considered in making up train mileage. Had the entire engine mileage been used, excepting switch engines, the cost per train mile would have been less, but the percentages used would have been greater.

The values deduced in this Bulletin are particularly for Union Pacific Railroad, but can be applied reasonably by other lines in the same section of the United States. Should other roads desire more accurate values for their own use, the methods outlined in the paper can be followed in full or

the proportions of each item affected be applied to the operating expenses of the road and reasonable values deduced.

Mr. Kingman's contention that trainmen's wages should be considered, no matter how short the distance, is not entirely correct. It depends wholly on whether actual or constructive mileage is used as a basis of pay for trainmen. On a great many roads the mileage allowance over a district is based on the nearest even number of miles between district terminals, the trainmen receiving the benefit of all distances of half a mile or less. Minor changes of distance which would not change the mileage allowance under these conditions are properly placed in class "A."

He is wrong regarding Class "C" distances, as all items of expense are not affected in direct proportion to the miles run.

It is true that I did not explain in the paper why curves are dangerous. I considered it unnecessary at that time and continue to consider it so. I concede Mr. Kingman's contention that a given number of degrees of heavy curvature creates a greater expense than would the same number of degrees of light curvature, but I have been unable to find actual figures showing the proportional increase due to increasing the degree of curve. Mr. Kingman gives some figures purporting to be costs of sharp curvature, but a study of these figures discloses the fact that they are not actual costs, but that he has used his judgment in computing most of the items, something which we have all had to do in estimating these values. Mr. Kingman's values per degree for various curves are also deduced by using his judgment and are based on a traffic of twelve trains each way per day. Values per degree per daily train each way are preferable to this system, as twelve trains each way per day is far too high for many roads to anticipate, and the use of tables prepared on a twelve-train basis would cause the engineer to spend more for work than necessary, the thing which Mr. Kingman claims his table of values avoids.

I would be pleased to have figures produced showing the actual additional expenses, as far as practicable, created by both light and sharp curvature, leaving as little for the judgment as possible in deducing values for the same.

The values deduced in Bulletin No. 49 are fair general values for curvature where curves in excess of five degrees are not used, and lighter curves used wherever they can be obtained in reason. The reason for using the 12 degree 30 minute curve for purpose of calculation is explained in the Bulletin and will not be repeated.

The Union Pacific would not retain an engineer in its employ who would "use a 4 degree curve where a 1 degree would be as cheap and shorter." All progressive railroads give their locating engineers definite instructions as to values for grades, curvature, distance and rise and fall, so Mr. Kingman does not stand alone in this matter. The summary on page 31 of Bulletin No. 49 was given to show values to be used by Union Pacific Railroad, but can be safely used by railroads operating under similar conditions as to cost of labor and material.

I can not concede that most all American engineers allow others to do their thinking for them. Personal acquaintance with many of them compels me to think that they are alive to all economical engineering questions.

There are a number of ideas advanced by the late Mr. Wellington that many of us take exceptions to, but as he is not here to answer on these points, we refrain from public criticism. Whatever the points on which we differ with him, we must acknowledge that in his great work, "The Economic Theory of Railway Location," he was a pioneer in giving the modern engineer food for thought. He did an enormous amount of research and in his great work has left us much material that is of immense benefit at the present time and will be so considered in the future.

MR. W. E. DAUCHY—(by letter) :—The writer was very much interested in reading Mr. Berry's able and valuable paper upon the Reduction of Gradient, and Elimination of Distance, Curvature, and Rise and Fall on Union Pacific Railroad, published in Bulletin No. 49. Mr. Berry's treatment of the subject of velocity grades being particularly interesting.

In considering the question of the money value of the elimination of curvature, widely varying results have been obtained by different engineers, and this must necessarily be the case until we have more definite data to work from. Mr. Berry has handled this subject very ably, but let us consider his figures for a moment.

He finds that the additional cost of operating a mile of line covered by a 12 degree 30 minute curve is 35.35 per cent. of the cost of operating a mile of line on a tangent. This additional cost is due to the increased cost of twelve of the thirty-seven items that go to make up the total cost per train mile. In looking over this list of thirty-seven items it is readily seen that these twelve items are the main ones whose cost is affected by curvature, although there are some others, such as repairs to bridges, repairs to telegraph line, frogs and switches (in case turnouts should come upon the mile of track under consideration), whose cost might be considered as being affected.

The extent to which the cost of these twelve items is increased is not so easily determined. The percentages as given in Mr. Berry's table are, at best, approximate, and a small variation in the increased cost of each item makes quite a large variation in the cost per degree of curvature on a busy line handling a large number of trains.

For example, if the additional cost of operating one mile of 12 degree 30 minute curve was taken at 40 per cent. instead of 35.35 per cent., and assuming there were twenty trains per day, the capitalized cost of 1 degree of curvature, considering money at 4 per cent., would be $130, instead of $115.

Could the increased cost of the train mile due to curvature be figured out exactly, however, the subject would not end there. There is a commercial value due to the elimination of curvature that cannot be figured with mathematical precision, and which varies with different conditions. At the present day the traveling public expects as few discomforts as possible, and riding over a crooked road is much more unpleasant than riding over a straight one; and where business is competitive (and most business at the present time is), the patronage will go to the straighter line.

The element of time also enters into the question, in considering both passenger and freight traffic. Trains can make faster time with safety upon a straight track than upon a crooked one, and in many cases the

time made between certain points is a controlling factor in obtaining business.

There is another value due to the elimination of curvature which might be termed the insurance value. I have in mind several disastrous and expensive wrecks which would not have occurred had not curves existed at or near the places at which such wrecks occurred. While the primary cause of such wrecks was in most cases due to the violation of rules or the misunderstanding of orders, still the fact remains that if the curves had not been there the wrecks would not have occurred.

Now if a wreck costing $15,000 occurs at or near a curve containing 30 degrees of curvature, which would not occur if the curve was eliminated, the money value due to the elimination of that particular curve would be vastly more than its capitalized cost from a train-mile standpoint.

Mr. J. B. Berry (Union Pacific—by letter) :—In regard to Mr. W. E. Dauchy's discussion of Bulletin No. 49, it is true that the percentage of items affected by curvature is but approximate. In making up these tables the conservative side has been taken, and in referring to Table No. 10 it can be seen that the items considered are such as would affect any curve. In case bridges or switches were located on curves, there would be some additional expense, but the three items mentioned by Mr. Dauchy—frogs and switches, repairs to bridges and repairs to telegraph—are only 2.31 per cent of the total cost per train mile, and even though a switch or a bridge occurred on a curve, the additional cost per train mile due to these items would hardly be appreciable. Mr. Dauchy appreciates the necessity of taking the conservative side in placing values on the various details of location affecting operating expenses, especially were he asked to make an estimate of the reduction in operating expenses of a proposed revision of line.

The writer can not agree with him regarding passenger traffic seeking the straighter line where competition exists. The business man takes the route making the quickest time, while the tourist takes the scenic route regardless of curvature. Those traveling below first-class usually have their routes selected by agents or other parties. Where curves are properly spiraled and with enough tangent between them to avoid shock in righting up the train, a line with such curvature can be made comfortable and easy riding. Sharp curvature will affect the speed of trains. In using these tables it must be considered that the sharpest curvature used by Union Pacific Railroad on its main line is five degrees, and very little of this. The great bulk of the curvature is less than three degrees, and any reduction in time because of such curvature does not affect passenger travel enough to be considered. No *conservative value* can be placed on the amount that public opinion would be affected by curvature.

Regarding what Mr. Dauchy terms the "insurance value" of curves: It is impossible to give a logical value per degree of curve, due to possibility of accident. As suggested in the first paragraph on page 19 of the Bulletin, any curve so situated as to obscure vision, or where local features make it particularly dangerous, must be considered by itself and judgment used as to the value of eliminating the curve.

REPORT OF COMMITTEE NO. VII—ON WOODEN BRIDGES AND TRESTLES.

To the Members of the American Railway Engineering and Maintenance of Way Association:

In accordance with instructions, your Committee has considered the subject of Wooden Trestles for railroads, and submits the following report:

SUMMARY OF CONCLUSIONS OF PREVIOUS REPORTS.

1900: In the preliminary report the Committee presented an outline of the manner in which it proposed to prosecute its work and formulate future reports. (Pp. 159-160, Vol. 1, 1900.)

1901: The report for 1901 contained papers on the following subjects: Pile and frame trestles; specifications for metal bridges; docks and wharves on the great lakes, docks and wharves for general freight purposes; freight sheds, transfer floats, ferries and bridges. The report contained no conclusions or recommendations. (Pp. 136-166, Vol. 2, 1901.)

1902: The Committee report for 1902 contained no conclusions or recommendations and was referred back for further consideration. (Pp. 288-294, Vol. 3, 1902.)

1903: The report for 1903 did not come before the convention for lack of time. (Pp. 27-30, Bulletin No. 31, 1903.)

HISTORICAL.

The history of wooden bridges and trestles is so closely identified with the first efforts in the line of common construction, that it was thought unnecessary to attempt to trace its origin, as it probably dates to the time when man first felled the tree across a stream to form a foot log.

ANALYTICAL.

Wooden trestles have served their purpose for many years, and made possible the construction of roads and railroads which might not otherwise have been built, but it is probable that they will eventually give way to more permanent structures built of steel, stone, or some other equally durable materials; yet wooden structures are in many cases advisable and necessary, and will doubtless be used to a greater or less extent on all railroads for many years.

The question of when wooden structures may properly be used instead of those of more permanent character depends on so many financial and local conditions, that your Committee has not attempted to offer any suggestion.

Your Committee submits the accompanying plans and specifications for frame and pile trestles, it being understood that they are not recommended as suitable for universal adoption, but as purely representative of the typical practice of the day. Local conditions, traffic, past practice, climate, etc., must determine such variations in these plans and specifications as may be necessary in each individual case.

The sizes shown on the plans are considered adequate for engines of the three general types and weights indicated by the diagrams, all of which will give fiber stresses in the stringers of 1,400 pounds per square inch. To what extent heavier loading may be permitted must be determined by the age and location of the structure, and whether the maximum loading is regular or occasional.

Accompanying this report are specifications for several kinds of bridge piling and timber.

DEFINITIONS.

WOODEN TRESTLE.—A structure composed of vertical members, supporting simple horizontal members or beams, the whole forming a support for loads applied to the horizontal members.

FRAME TRESTLE.—One in which the vertical members or supports are framed timbers.

PILE TRESTLE.—One in which the vertical members or supports are piles.

BENT.—The group of members forming a single vertical support of a trestle, designated as pile bent where the principal members are piles, and as framed bent where of framed timbers.

POSTS.—The vertical and battered members of the bent of a framed trestle.

PILES.—Timbers driven in the ground and intended generally to support a structure.

BATTER.—The deviation from a perpendicular in upright members of a bent.

CAP.—The horizontal member upon the tops of piles or posts connecting them in the form of a bent.

SILL.—The lower horizontal member of a framed bent.

SUB-SILLS.—Timbers bedded in the ground to support framed bents.

INTERMEDIATE SILL.—A horizontal member in the plane of the bent between the cap and lower sill and into which the posts are framed.

SWAY BRACES.—Members bolted or spiked to the bent and extending diagonally across its face.

LONGITUDINAL STRUTS OR GIRTS.—Stiff members running horizontally or nearly so from bent to bent.

LONGITUDINAL X BRACES.—Members extending diagonally from bent to bent in vertical or battered planes.

SASH BRACES.—Members secured horizontally to the posts or piles of a bent.

STRINGERS.—The longitudinal members extending from bent to bent and supporting the ties.

SAFETY OR JACK STRINGERS.—A single line of stringers placed outside of the main stringers.

TIES.—Transverse timbers resting on the stringers and supporting the track.

GUARD RAILS.—Longitudinal members, either iron or wood, secured on top of ties.

PACKING BLOCKS.—Small members, usually wood, intended to secure the parts of a composite member in their proper relative positions.

PACKING SPOOLS OR SEPARATORS.—Small castings used in connection with packing bolts to secure the several parts of a composite member in their proper relative position.

DRIFT BOLT.—A long piece of round or square iron with or without head or point driven as a spike.

DOWEL.—A short iron or wooden pin used to connect members.

SHIM.—A small piece of wood or metal placed underneath any portion of a structure to bring it to a desired elevation.

FISH PLATE.—The short piece secured to the side of several members which are butt jointed.

BULKHEAD.—Timber placed on edge against the side of an end bent for the purpose of retaining the embankment.

SPECIFICATIONS FOR TRESTLES.

Proper surface of the track is to be secured by carefully framing and adjusting the lengths of the posts or piles in the bents; where super-elevation is required for the track on curves, it shall be made in the lengths of the posts or piles, the cap being inclined to correspond.

Material. Lumber should preferably be white pine, long-leaf Southern pine, Douglas fir, or white and burr oak, cut from live trees, and sawed square in section, free from wind shakes, large or unsound knots, any defects that impair its strength, and generally free from sap wood. Piles should preferably be cedar, native white or burr oak, heart cypress, long-leaf Southern pine, Douglas fir, white pine and tamarack.

Length of Spans. All spans to be fourteen feet centers, except end spans, which shall be thirteen feet six inches centers; using stringers of two span lengths. Where longer stringers can be economically obtained, longer spans may be used.

Foundation. The foundation for framed trestles may be piles, wooden sub-sills, or masonry.

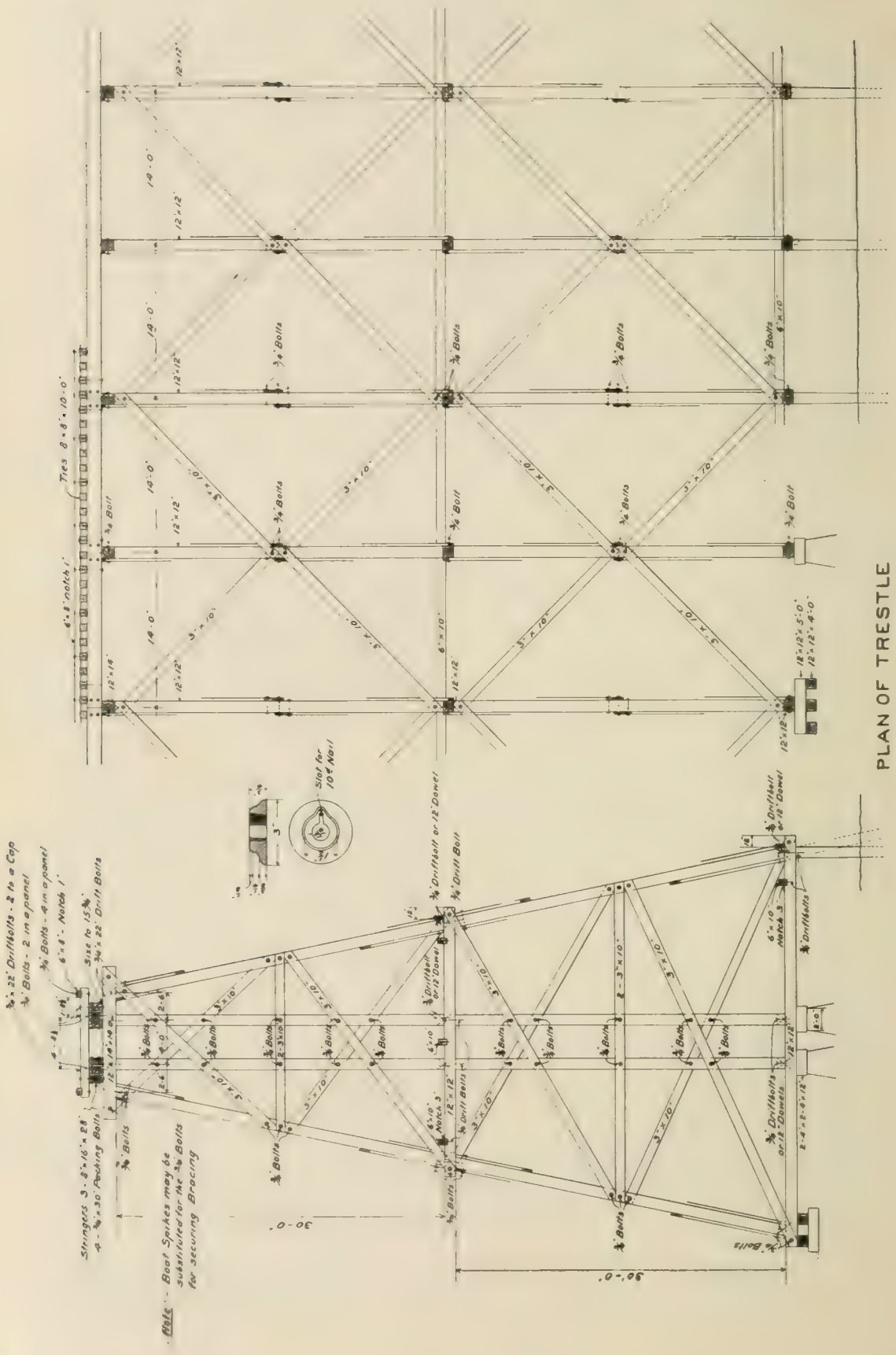

PLAN OF TRESTLE
Ties 8"x8"x10'-0"
Slot for 10" Nail
Stringers 3-8"x16"x28'
4-8"x30' Packing Bolts
Size to fit
Notch 1"
Drift Bolts
Drift Bolt or 12" Dowel
Drift Bolt
Notch 3"
Drift Bolts or 12" Dowels
Bolts
Note:- Boat Spikes may be substituted for the 3/4" Bolts for securing Bracing

FIG 2.

Am. Ry. Eng. & M. W. Assn.,
Convention of 1904.
Committee on Wooden Bridges and Trestles.
PLAN OF FRAME TRESTLE.

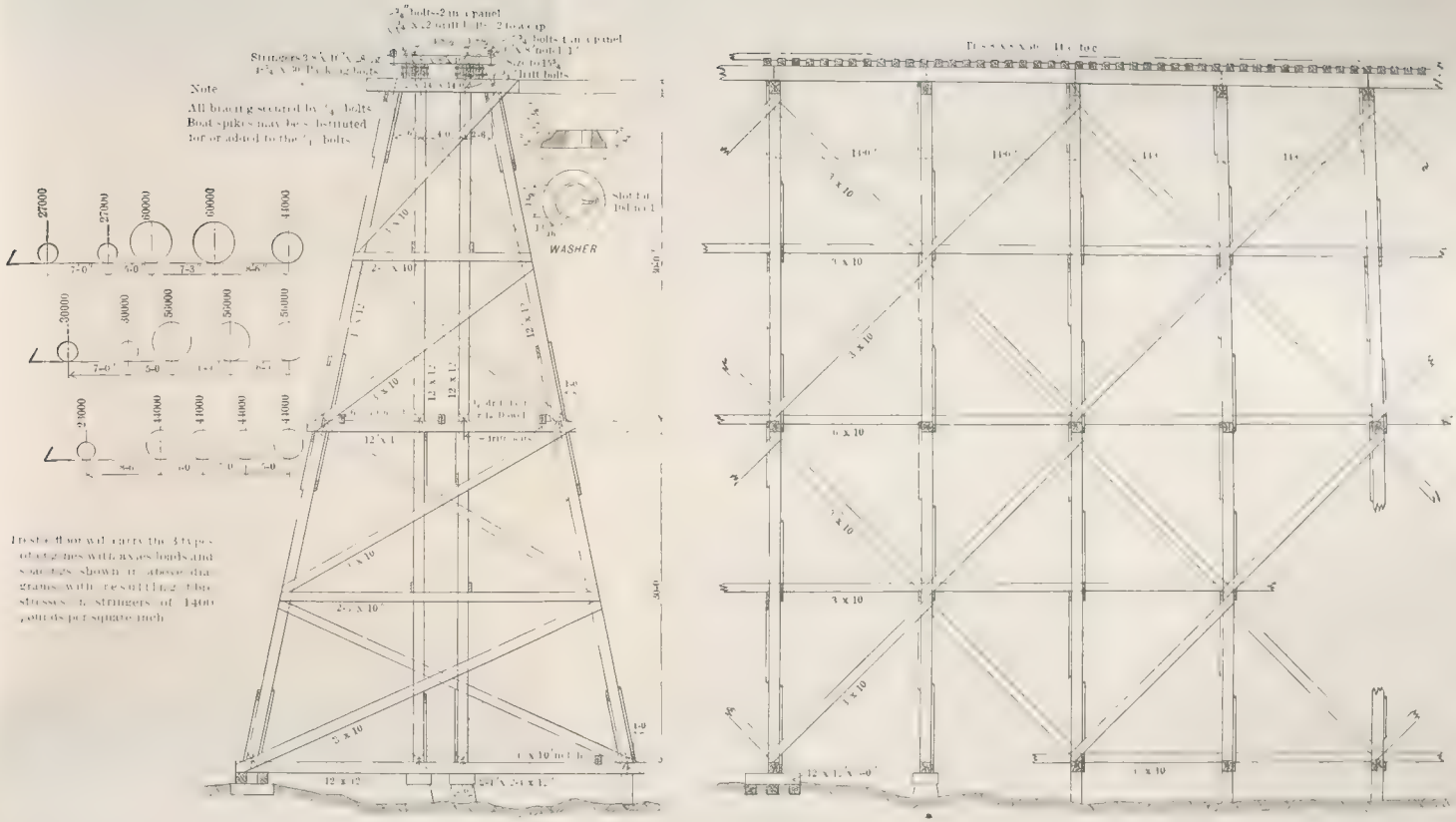
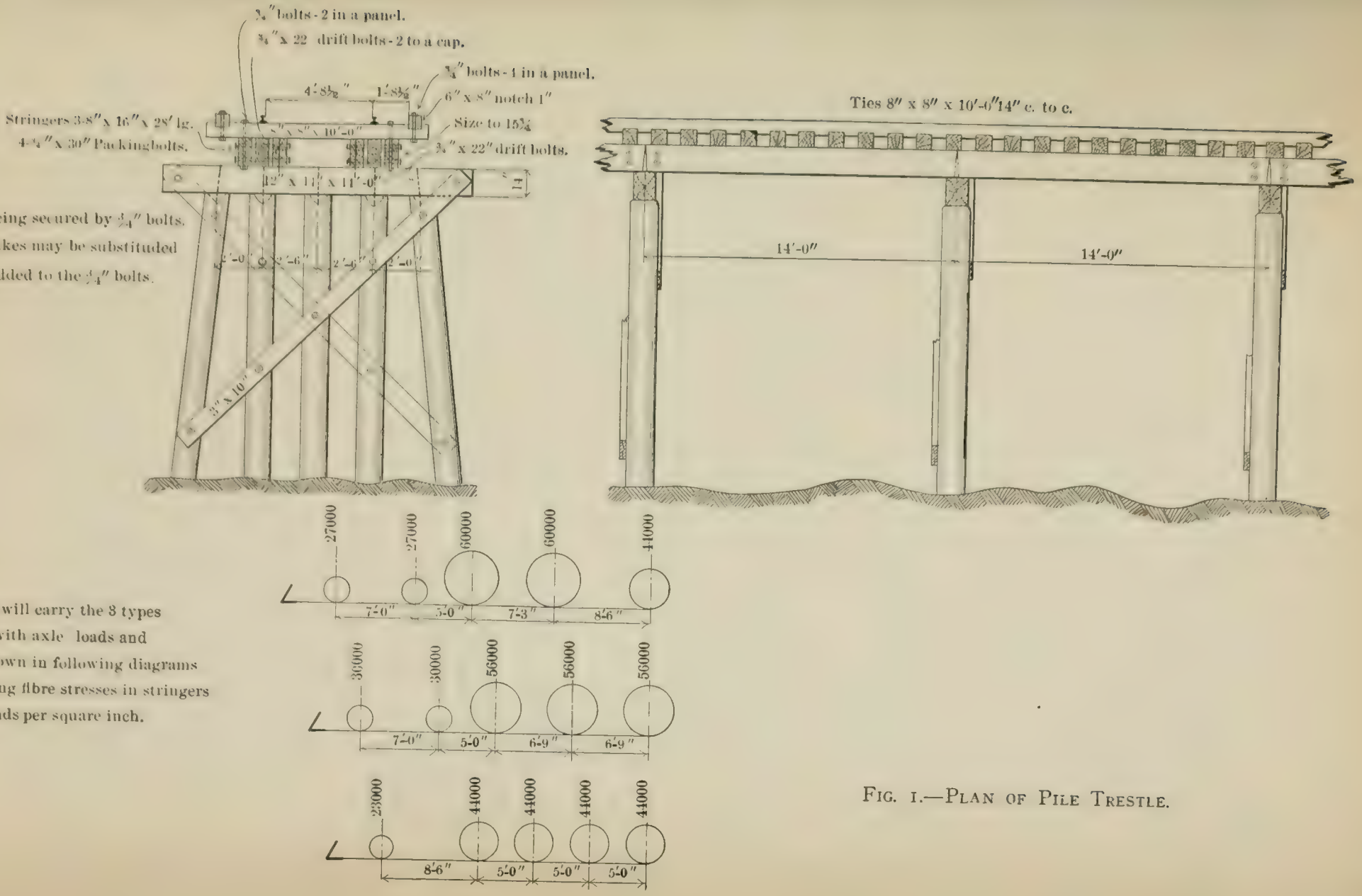


FIG. 2.—PLAN OF FRAME TRESTLE.



Note:

All bracing secured by ¾" bolts.

Boat spikes may be substituded for or added to the ¾" bolts.

Trestle floor will carry the 8 types of engines with axle loads and spacings shown in following diagrams with resulting fibre stresses in stringers of 1400 pounds per square inch.

FIG. 1.—PLAN OF PILE TRESTLE.

Sills. Sills for framed trestles will be 12x12 in., in section, securely drift-bolted or anchor-bolted to the foundation.

Posts. Posts shall be 12x12 in., in section, properly framed and secured with drift bolts or dowels; the outside posts to be battered from 2 to 3 in. in 12 in.

Caps. Caps to be 12x14 in., in section, 14 ft. long, and drift-bolted to posts or piles with ¾-in. drift bolts.

Sway and Sash Braces. The bents to have 3x10-in. sway and sash braces, fully secured with ¾-in. bolts or boat spikes at each point of contact.

Longitudinal Struts or Girts. Longitudinal struts or girts to be 6x10 in., notched 3 in. over intermediate sills, and secured with ¾-in. drift bolts.

Longitudinal X Bracing. Longitudinal X bracing to be 3x10 in., there being at least three lines in each panel.

Stringers. There will be three lines of 8x16-in. stringers (long-leaf Southern pine or Douglas fir preferred) for each rail, laid with broken joints and bolted together with ¾-in. bolts and cast iron packing spools. The stringers to be secured to the caps with two drift bolts for each cap.

Ties. Ties to be 8x8 in., 10 ft. long, sized over the stringers. Two ties in each panel to be bolted to the stringers and every alternate tie spiked to the stringers with ½x12-in. boat spikes.

Guard Rails. Guard rails to be 6x8 in., laid flat, and notched at least one inch over the ties.

Bulkheads. Bulkheads to be of good old timber, cut to the slope of the bank to hold the earth or ballast.

Where lumber or piles are treated by some approved method, other kinds of wood than those herein mentioned as preferable, also other methods of construction, such as solid wood ballast floor bridge, may be desirable.

SPECIFICATIONS FOR PILES AND TIMBER.

Piles. All piles of whatever kind shall be cut from growing trees, free from wind or heart shakes, large or unsound knots, decay or other defects which would impair the strength or durability of the pile. Only butt cuts, cut above the ground swell of the tree, and with both ends cut square, will be accepted. They shall be peeled of bark and the knots trimmed, and the specified sizes shall be, after peeling, straight and uniformly tapering.

Oak Piles. Shall be of the variety of white, burr or post oaks, with wood of close, firm grain, and with a sap ring not over 2 in. in thickness. They shall be not less than 12 in. in diameter at 6 ft. from the butt, and when 28 ft. or less in length they shall be 10 in. in diameter at the top or small end, and where 30 ft. in length or longer shall be not less than 9 in. at the top.

Norway and Tamarack Piles.

These shall not be less than 14 in. or more than 18 in. in diameter at the butt, and where 36 ft. or less in length shall be not less than 10 in. in diameter at the top, and where over 36 ft. in length shall not be less than 9 in. at the top.

Long Leaf Pine Piles.

These shall be strictly long-leaf Southern or yellow pine, and no doubtful grades will be accepted. They shall be hewed square, with all the sap removed. They shall be not less than 12 in. or more than 14 in. square at the large end, or 8 in. square at the small end, and must be smoothly hewed without large or deep score hacks.

Cedar Piles.

These shall be of white or red cedar. White cedar piles shall be not less than 14 in. in diameter at the butt and 9 in. at the top where less than 30 ft. in length. Where over 30 ft. in length they shall be not less than 8 in. in diameter at the top. Unsound butts will be accepted if the defect is not more than 5 in. in diameter, and there must be at least 5 in. of sound wood all around the defect. Red cedar piles shall be not less than 12 in. at the butt and 8 in. at the top.

Timber.

All timber of whatever variety shall be cut from sound live trees, and shall be sawed full size, square in section and out of wind. It shall be free from wind shakes, large or unsound knots, pitch seams, decay or any other defects which would impair its strength and durability, and shall generally be free from sap.

Long Leaf Pine.

This shall be of the variety known as long-leaf Southern or yellow pine, and no loblolly or other doubtful grades will be accepted. The wood must be close, firm grained and free from red heart or red-heart streaks; sound knots not over 1¼ in. in diameter will be allowed, but knots must not be in groups. Sap wood will be allowed on one or more of the four sides to an extent of not more than 15 per cent. of the surface of any one side, and at any one point throughout the length of the piece.

Fir.

This shall be of the variety of Douglas fir, sometimes called Oregon or Washington fir, and may be the yellow or red varieties, preferably the first. It shall not have at any point of its length and at any edge sap wood more than 2 in. in width, and shall be free from knots over 1½ in. in diameter, except that in long stringers sound knots not over 2½ in. in diameter will not be cause for rejection if not more than 4 ft. from the end.

CONCLUSIONS.

The Committee recommends the adoption by the Association of the Definitions of Terms contained in the report.

The Committee recommends that the Specifications submitted be approved by the Association as being good practice.

Respectfully submitted,

D. W. LUM, *Chairman;* Chief Engineer Maintenance of Way and Structures, Southern Railway, Washington, D. C.

C. F. LOWETH, *Vice-Chairman;* Engineer and Superintendent Bridges and Buildings, Chicago, Milwaukee & St. Paul Railway, Chicago, Ill.

F. M. BISBEE, Civil Engineer, Ft. Madison, Iowa.

H. G. FLEMING, President and Chief Engineer, Belt Railway, Memphis, Tenn.

W. A. GRONDAHL, Resident Engineer, Southern Pacific Company, Portland, Ore.

F. P. GUTELIUS, Engineer Maintenance of Way, Canadian Pacific Railway, Montreal, Canada.

J. C. HAUGH, Resident Engineer, New Orleans & Northeastern Railway, New Orleans, La.

THEO. D. KLINE, General Manager, Central Railroad of Georgia, Savannah, Ga.

W. I. LEE, Assistant Engineer, Seaboard Air Line, Cedartown, Ga.

C. C. MALLARD, Division Engineer, Southern Pacific Company, Algiers, La.

F. C. MILLER, Resident Engineer, Southern Pacific Company, Sacramento, Cal.

A. F. ROBINSON, Bridge Engineer, Santa Fe Railway System, Topeka, Kan.

O. J. TRAVIS, Superintendent Bridges, Colorado Southern Railway, Denver, Colo.

JOB TUTHILL, Bridge Engineer, Pere Marquette Railway, Detroit, Mich.

I. O. WALKER, Assistant Engineer, Nashville, Chattanooga & St. Louis Railway, Paducah, Ky.

Committee.

DISCUSSION.

MR. F. W. RANNO (Southern Indiana—by letter) :—Referring to the last committee report on Wooden Bridges and Trestles, in the specifications under the item of ties, it calls for "every alternate tie spiked to stringers." Just above this it calls for two ties in each panel to be bolted to the stringers. In my opinion, this bolting is all that is necessary, the spiking being wholly unnecessary and harmful to the stringers. The spike cuts the top of the stringer, so that water can readily get in, and thereby promotes decay. I would recommend that the portion of this specification that calls for ties spiked to stringers be stricken out. On most of the rails that I am acquainted with the ties are not fastened to the stringers at all, except by notching. Some notch each tie and others only every third tie.

MR. W. MCNAB (Grand Trunk—by letter) :—This report is condensed into such reasonable compass that remarks will be much simplified.

It will be noticed that after reference to the purpose that wooden structures have served in the past, the report says:

"Yet wooden structures are in many cases advisable, and will be used to a greater or less extent on all railroads for many years."

It may be assumed that this reference to wooden structures means, in general, trestles, rather than trussed spans, yet the days of trussed wooden spans as temporary expedients in some localities are not over yet, and it would have been well if the report had contained some reference to such structures.

Regarding historical data, although it may not have been necessary to trace the origin of wooden bridges in common construction, yet a short account of the evolution of construction in regard to their use by railroads would have been interesting for record in the Proceedings of the Association.

Within the memory of many engineers yet in active life are the days when there were in general use the various forms of wooden lattices, the McCallum trusses, Howe trusses, those with strengthening arches, and the various forms of combinations of wood and iron, and although one may find information on such matters by searching here and there for it in old literature, yet this year, when special research was generally being made in regard to development, some notes in regard to these structures would have been an interesting supplement to this report, and it may be hoped that the Committee will yet find time to place such data on record.

The last two clauses in the report are to the point, and emphasize the fact that competent men only should deal with such matters.

In regard to the definitions, those given below in *italic letters* are respectfully suggested as being more definite:

GUARD RAIL.—Longitudinal members, either iron or wood, secured on top of ties.

Longitudinal members, either iron or wood, secured on top of ties, to minimize injury in case of derailment of rolling stock.

SHIM.—A block used to raise any portion of a structure (and is generally evidence of faulty construction).

A block of wood or metal placed underneath any portion of a structure to bring it to proper elevation.

BULKHEAD.—Timber placed on edge against the side of an end bent for the purpose of retaining the embankment.

Timber placed on edge against the face of an end bent for the purpose of retaining the embankment.

LONGITUDINAL X BRACES.—Members extending diagonally from bent to bent, in vertical planes.

Members extending diagonally across the batter posts from bent to bent, in vertical planes.

MR. D. B. DUNN (Seaboard Air Line—by letter):—I do not wish to criticise the character of the work done by this Committee along the line they have elected to frame their report, but I cannot help but look upon it as an apology for a report upon a character of structures that are beginning to be looked upon as obsolete, in the light of the "more permanent structures built of steel, stone, or some equally durable materials." When it is further admitted, however, that "wooden structures are in many cases advisable and necessary, and will doubtless be used to a greater or less extent on all railroads for many years," it is pertinent to ask the question, in view of the fact that all other forms of bridging are figured to meet enormously increased loads, what has the Committee given us to meet the requirements where, from any cause, in the construction or reconstruction of a high-grade railroad of to-day, these structures become a necessity?

We have a very stable deck system on a span that is conservative for the measure of stability given, but from the guarded character of the recommendations indulged in, I question whether the Committee would advise using a four-post bent, with a single system of 3x10 in. lateral bracing, for 60 ft. in depth, and presumably for greater depths, and with 3x10 in. longitudinals, 20 ft. in length, to stay vibration, for a loading of Coopers E 50, or even E 40, on heavy traffic, at the speeds in use.

Since we must use wooden trestles, why not take the same pains to ascertain the requirements for stability in bents, varying in degree from ten to one hundred feet in depth, that would be taken if we had the

same problem to meet in designing a steel viaduct, beginning with the ordinary four-post bent at the top and adding to it the full measure of stability required for each increasing deck in depth? Add to this a stiff system of longitudinal bracing sufficient to stay vibration, and we fill the requirements.

Every engineer on new construction to-day, where he is obliged from any cause to use trestles, has this problem to meet, and solves it, in most cases, and the roads that have increased their loads and have the old simple form of trestle awaiting renewal in some stable form are on the anxious seat.

It seems to me it should be the province of this body to work along the lines that lead, rather than present types that will not stand criticism in the light of present-day requirements. The men who framed this report are eminently capable of giving us all we need in this direction, and I with many others would like the benefits to be derived from their experience.

As others differ from me, however, as to the expediency of spending time on this character of structure, in order to call out an expression of the members, I propound the question: "Is it not desirable that we should have structures in wood fully up to present-day requirements, when from any cause we are compelled to use them?"

MR. W. C. CUSHING (Pennsylvania Lines—by letter):—There are a few things in the Committee's specifications which I think could be changed to advantage, and the best way to express them is to show a plan of our standard trestle.

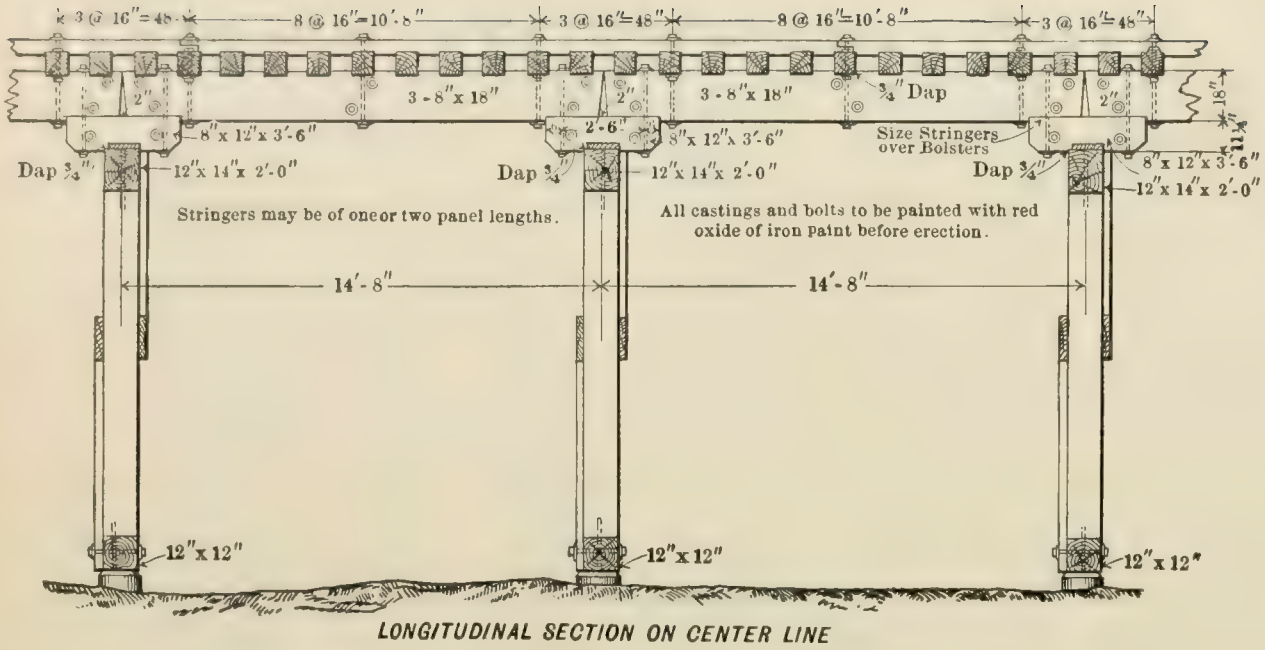
The thirty-foot stick is a merchantable length and can be used most economically for spans 14 ft. 8 in. long, instead of 14 ft., as recommended by the Committee.

In recommending the stringer sizes there is no information given by the Committee concerning the weight of engine used for calculating the necessary strength required. I think it would be much better for the Committee to furnish a table showing the different sizes of stringers required for different weights of engines. It can not be said that 8x16-in. stringers are sufficient on railroads with very heavy engines.

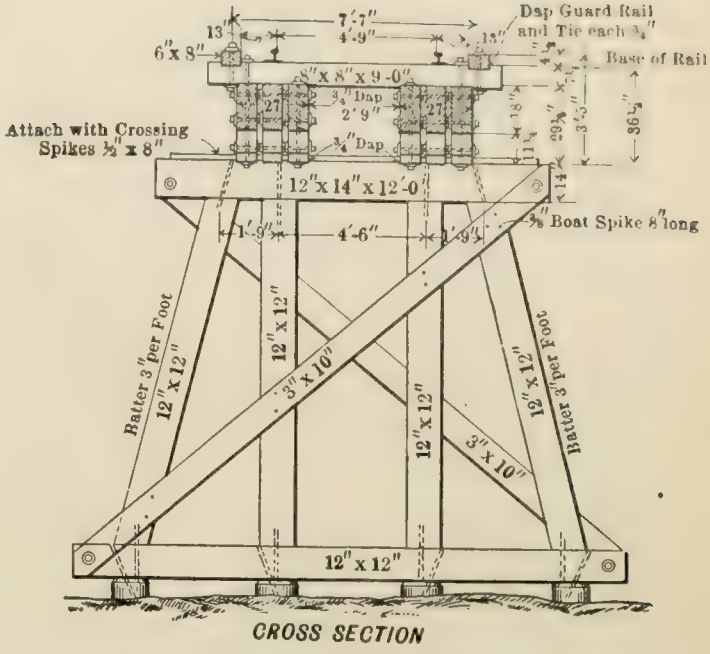
I also think the material specification is rather too general for purchasing timber for trestles, and in order to make my idea clear, I hereto attach a copy of the specifications of the Pennsylvania Lines West of Pittsburg.

(EXTRACT FROM SPECIFICATIONS FOR MAINTENANCE OF WAY LUMBER, PENNSYLVANIA LINES WEST OF PITTSBURG.)

OAK.—Bridge Cross-Ties.—Must not have more than one inch of sap on one corner; three corners must be free from sap. They must be fairly straight grained, and of even thickness and width, of full size and length ordered. Sound knots not over 1½ in. in diameter, so located as not to impair the strength or durability of the piece, will be accepted.

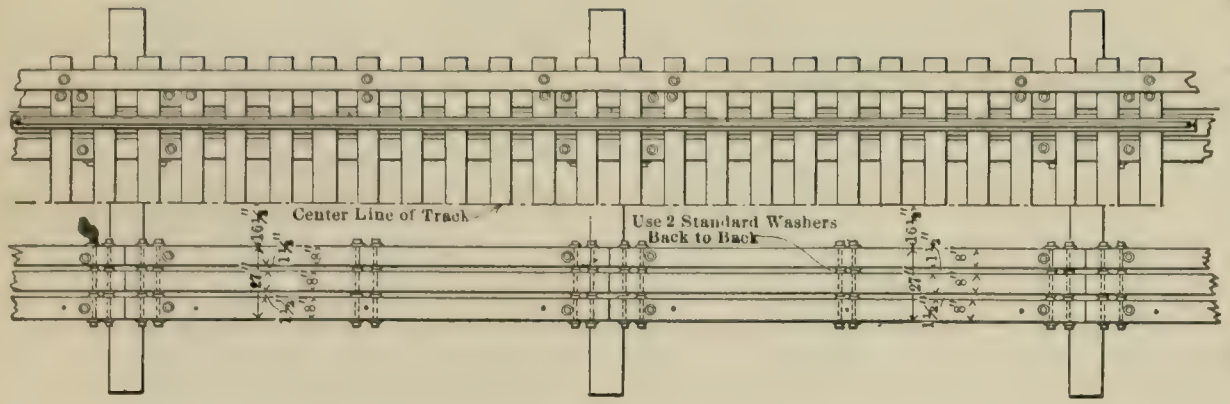


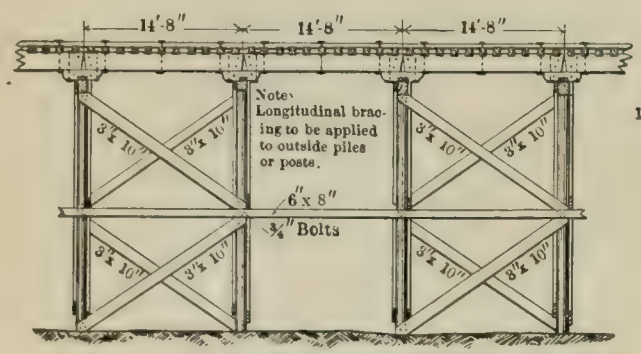
LONGITUDINAL SECTION ON CENTER LINE



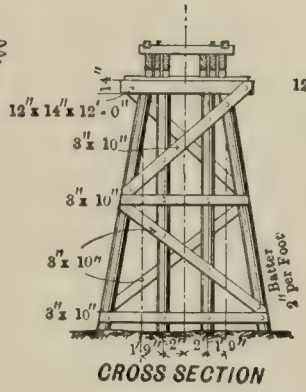
CROSS SECTION

STANDARD TRESTLE—FRAMED AND PILE—PENNSYLVANIA LINES, WEST OF PITTSBURG.





SIDE ELEVATION



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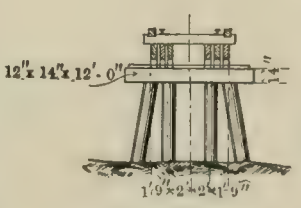


CROSS SECTION

STANDARD TRESTLE—FRAMED AND PILE—PENNSYLVANIA LINES, WEST OF PITTSBURG.

All drift bolts to be ¾" diam., 20" long.

All screw bolts to be ¾" diam., with standard head and nut and cast washers.

SIZES OF STRINGERS FOR 15 FEET SPANS.

Engine.		Maximum Bending Moment per Rail with Allowance for Shock, Ft. Lbs.	Practical Sizes to Use.		
Old Name.	New Name.		White Pine F = 1000	Oregon Fir F = 1200	Yel'w Pine F = 1500
O	D10A	90 500	3 8"x18"	3 8"x15"	2 8"x18"
P	D13A	109 200	3 8 x18	3 8 x16	2 8 x18
L	D16A	126 100	3 8 x20	3 8 x18	2 8 x20
Mogul	F1	130 600	3 8 x20	3 8 x18	2 8 x20
E	G2	86 700	3 8 x16	3 8 x15	2 8 x16
X	G3	140 500	3 8 x22	3 8 x20	2 8 x22
I	H1	89 300	3 8 x16	3 8 x15	2 8 x16
S	H2	100 500	3 8 x18	3 8 x16	2 8 x18
R. 93	H3B	126 500	3 8 x20	3 8 x18	2 8 x20
H 4	H4	151 200	3 8 x22	3 8 x20	2 8 x22
100000 lb.	100000 lb.	131 400	3 8 x20	3 8 x18	2 8 x20
SteelCars	SteelCars	136 400	3 8 x20	3 8 x18	2 8 x20
.....	G4A				

NOTE—In general use only 8"x18" and 8"x20" stringers.

Where 3 8" x 20" sticks under each rail are not sufficient for a span of 14' 8", the span should be reduced, its length to be a multiple of sixteen (16) inches.

Superelevation of one rail should be made by the piles or posts.

When the trestles consist of more than 3 spans, and where height of bent is 15 feet or over, the trestle should be braced longitudinally.

FRAMED TRESTLES.—Stories should not exceed twenty-five (25) feet in height from center of sill to center of cap. Conditions as to grade, speed of trains, etc., should be considered in connection with longitudinal and other bracing. Trestles more than twenty-five (25) feet high will be the subject of special design, to be approved by the Chief Engineer.

PILE TRESTLES.—Cross bracing should be used when the height exceeds twelve (12) feet. Conditions should be considered as in the case of framed trestles.

OAK.—Trestles: Caps, Posts, Sills.—No sap will be allowed on timber 6 in. by 6 in. or less in size; over 6 in. by 6 in., 1 in. of sap will be allowed on two corners. Sound knots, not over 1½ in. in diameter will be allowed, if they do not impair the strength of the piece.

OAK.—Bridge Stringers.—Sound knots not over 1½ in. in diameter will be allowed when so located as not to impair the strength or durability of the stick. One and one-half in. of sap will be allowed on two corners. Timber must be straight grained.

OAK, BEECH, ELM AND MAPLE.—Foundation Timber for Bridges and Culverts.—Must be of good, common quality, free from decay; sap will be permitted on all corners, not exceeding 2 in. Timber must be sawed square, 12 in. by 12 in.; in lengths, 10, 12, 14 and 16 ft., as ordered.

LONG LEAF PINE.—Bridge Cross-Ties, Bridge Floor Guard Rail, Bridge Stringers, Trestle Caps and Posts.—Sound knots not exceeding 1½ in. in diameter will be allowed in sizes 8 by 8 or under, and sound knots 2½ in. in diameter for sizes over 8 by 8 will be allowed, provided number and location of same does not impair the strength or durability. Must be free from splits, shakes, decay in the form of red streaks on ends or face (generally known as red heart), or other defects that impair the strength and durability. Not more than 1 in. of sap will be allowed on one corner of pieces 8 by 8 or less. Not over 1 in. of sap will be allowed in two corners of pieces over 8 by 8 in. and under 12 by 12 in. Not over 1½ in. of sap will be allowed on four corners of pieces over 12 in., the measurement being taken on the deep face of the stick.

WHITE PINE.—Bridge Stringers, Trestle Caps, Posts and Sills.—No sap will be allowed on timber 8 by 8 in. or less; over 8 by 8 in., 1 in. sap will be allowed on two corners. Must be straight grained, with four good corners. Sound knots will be allowed, if their size and location do not impair the strength or durability.

OREGON FIR.—Bridge Stringers.—Must be yellow fir, straight-grained heart lumber, clear of sap, splits, wind shakes, loose or decayed knots, or other defects which would impair the strength or durability. Sound knots not exceeding 1½ in. diameter will be allowed, except when so located as to impair the strength or durability.

OAK, ELM AND BEECH.—Piles.—Piles 25 ft. long, or less, must be at least 10 in. in diameter at smaller end, and over 25 ft. 12 in. in diameter at smaller end. No piles shall be less than 14 in., nor over 16 in. in diameter, 4 ft. from the butt. All limbs must be trimmed close to the body of the trees, and all bark removed. They must be straight.

PROF. W. K. HATT (Chief, Section of Timber Tests, Bureau of Forestry, United States Department of Agriculture—by letter):—The Bureau of Forestry has under operation a series of practical tests to determine the actual value of the different species of timber for use in structures. Up to the present time the great majority of the tests have been on small sticks, with a view of determining relations of purely scientific interest. It is a well known fact that tests on small selected sticks, 2 in. x 2 in. or 4 in. x 4 in. in cross-section, do not yield moduli which are appropriate for the design of large structures. The main object of the Bureau of Forestry in undertaking these tests is to show the structural value of timbers which will probably be on the market for an indefinite time, because of the fact that the operations of conservative forest management contemplate a perpetual harvesting of these timbers from timberlands.

For instance, the Loblolly Pine is a tree which may be grown on timber lands as a crop, and cut, after a definite term of years, in the same way that a farmer handles his farm. The difference is that the harvest of the farmer comes every year, but the harvest of the lumberman may come in a period of time, 40 to 60 years in the case of Loblolly Pine.

The species of structural timber which are now under test include the Loblolly Pine, the Red Fir of the Pacific Coast, and the Western Hemlock. The sizes at present being tested run 8 in.x16 in. down to 5 in.x8 in., namely, stringer and car sill sizes. The timber is in all cases selected from the lumber yard, and full information obtained concerning the origin of the timber and the degree of seasoning. Photographs are taken of the sides and ends, and all knots and other defects located. The timbers are in all cases given an exact market grade.

Part of the use of the tests will be to standardize and correct the present rules of grading, information being obtained which will enable engineers to decide exactly what defect it is that should throw a timber from a merchantable grade to a second grade.

The tests are being made on timbers at various degrees of seasoning, in order to obtain the relations between the strength in the green state and the "yard-dry" state.

The tests also concern themselves with the relative strength of these woods in their natural state and after they have been preserved by various preservative processes. The information obtained will enable specifications for the lumber to be improved. There are at the present time a good many factors in these specifications, which add unnecessary friction to trading operations. For instance, inclusion in the specifications of such requirements as that the timber shall be "live" timber, shall be "unbled" timber, or that there shall be no "sap stains," or shall be "butt cut," are requirements which should be omitted. What concerns the engineer is the quality of timber as it comes to him, and it should be inspected with reference to the defects present therein, and not with respect to factors which may, under certain circumstances, yield defective timbers, and may in other cases yield stronger timbers.

It is well known to those who have most familiarized themselves with the facts, that the effect of bleeding Long Leaf Pine is confined to the sap of the wood, and does not affect the heart, out of which the structural timber usually comes. Nor is there any way of knowing from the appearance of a stick whether the tree has been bled or not, unless the presence of a "burn" or excessive resin, rendering the wood translucent, discloses the fact. It is also a well-known fact to botanists that the heart of the timber may be considered as dead material, and that the timber which has been killed by fire, provided it has not been standing long enough to allow the intrusion of boring insects or rot, is as strong as what is called "live timber." It has further been well established that sap stain does not decrease the strength of the joists for architectural use.

The tests also include scientific observations to determine the effect of moisture on the mechanical properties of the wood, and the relative strength under quickly applied loads and loads applied for long periods of time.

It is proposed to issue a bulletin this summer, giving an account of the results of the investigation, as thus far advanced.

Mr. A. M. Shaw (Chief Engineer, Northern Illinois Electric Railway—by letter) :—Referring to the "Plan of Frame Trestle" given in the report of the Committee on Wooden Bridges and Trestles, in Bulletin No. 48. I would like to call attention to the amount of dap recommended in the guard rail, which is one inch. I would recommend a dap of "not less than one and one-half inches." My reason for this is that in actual practice it is common to accept ties that have more or less sap, and this sap usually comes in such a position that as the tie decays, it gives a round corner to the tie, causing the guard rail to lose its hold on the tie if the dap is shallow. My experience has been mostly with five-inch guard rails dapped one inch, and while this has been sufficient to keep the ties from "bunching" in case of a derailed truck while the deck is new, it will not prevent this as the deck gets older. If it is thought that the full five inches of guard rail above the ties would be best, I would recommend a larger timber for guard rail, though I think that four and one-half inches is sufficient. I have seen a great many cases of derailed trucks where the outer wheel has struck the guard rail and been caused by it to follow parallel to the rail, but have seen but one such case where the wheel has mounted the guard rail, though the guard rail stood only four inches above the tie.

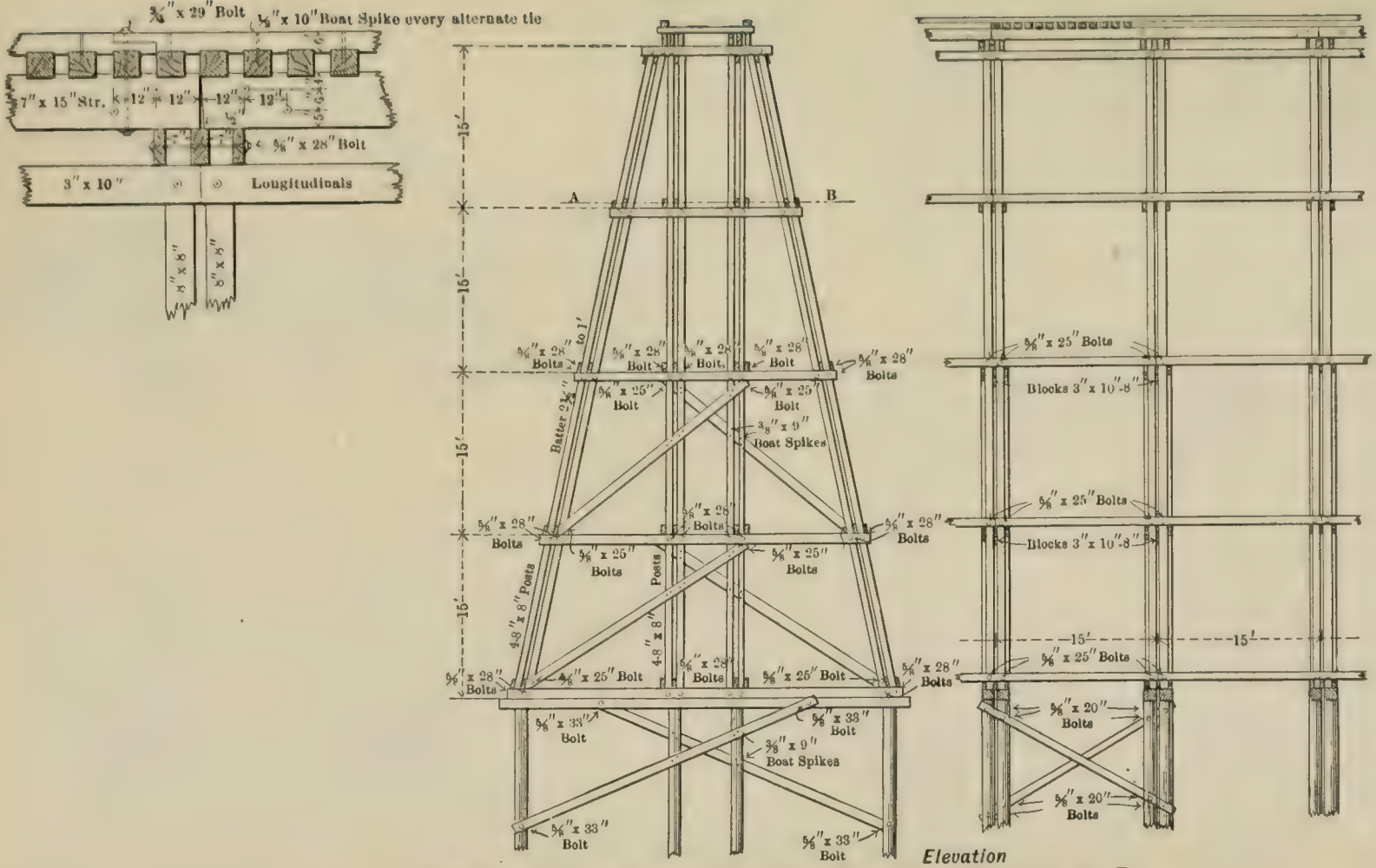
Mr. Duncan MacPherson (Canadian Pacific—by letter) :—I would submit the following remarks on the report on Wooden Bridges and Trestles: Definitions:

Sash Braces.—The proposed definition, "Members secured horizontally to the posts or piles of a bent," would apply equally to the caps and sills. I would suggest, "Horizontal members bolted or spiked to the sides of posts or piles of a bent."

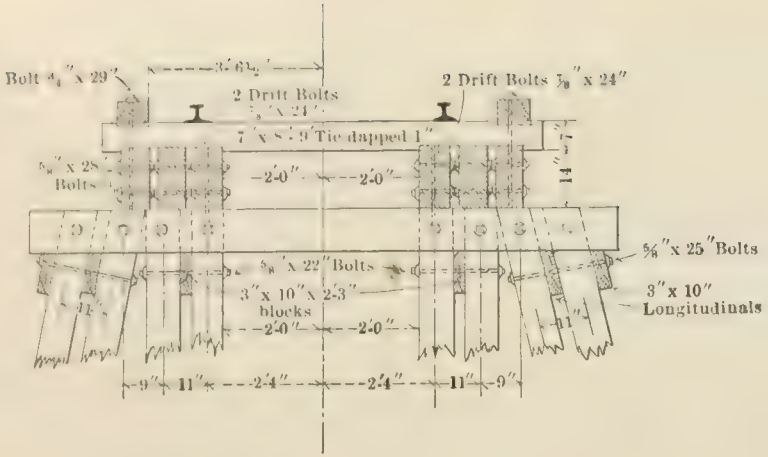
Specifications.—Three 8x16-in. stringers under each rail are scarcely large enough for spans of 14-foot centers, on important lines, with present heavy engines. They should be at least 10 in. or 12 in. wide and 16 in. deep.

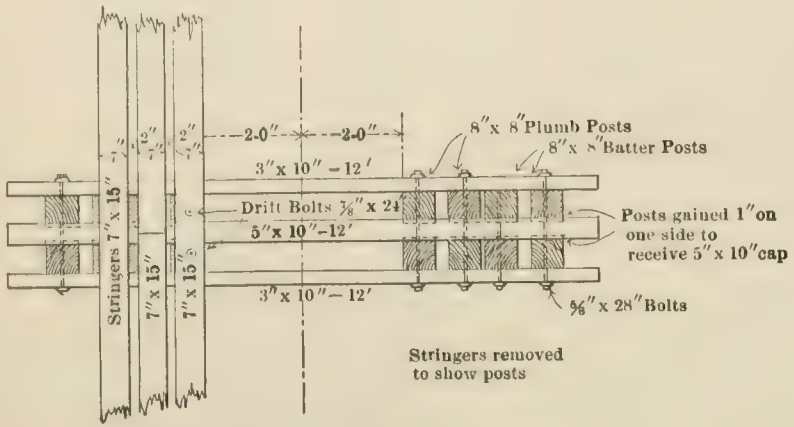
Mr E. Holbrook (Missouri, Kansas & Oklahoma—by letter) :—In looking over the design for pile trestles in this report, the question occurs to the writer as to whether we have sufficiently considered the effects of such engine loading as is there given, especially for such speeds as such structures are subjected to under the present-day high-speed passenger trains.

The writer knows, from practical experience, that, even under power considerably lighter than that given, the life of caps is discouragingly short and the deflection of stringers undesirably great. Owing to the usual practice in counterbalancing engines, the vertical resultance of engine load travels transversely back and forth across the bridge as the engine

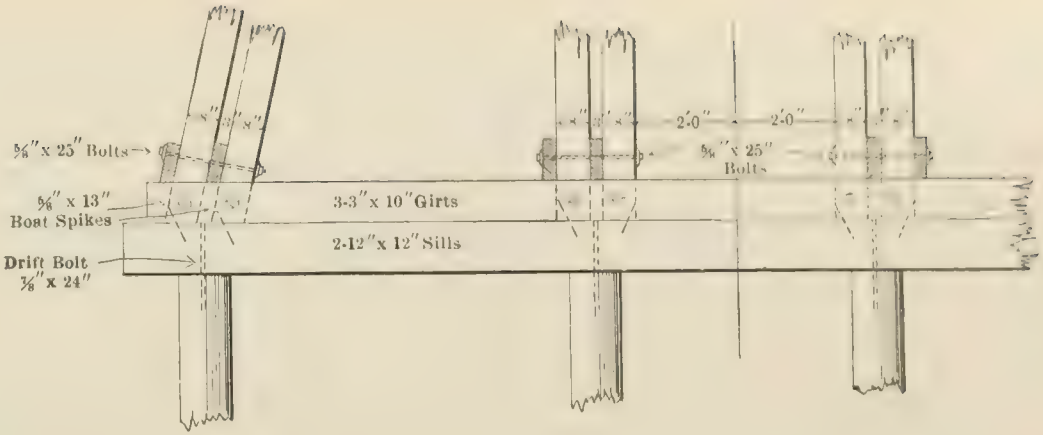


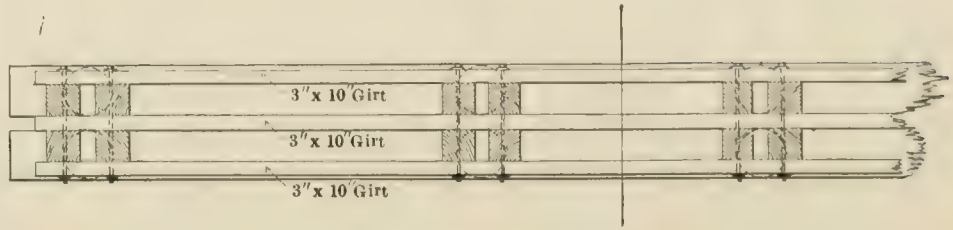
PLAN OF CLUSTER BENT TRESTLE, MO., KAN. & OKLA. R. R.



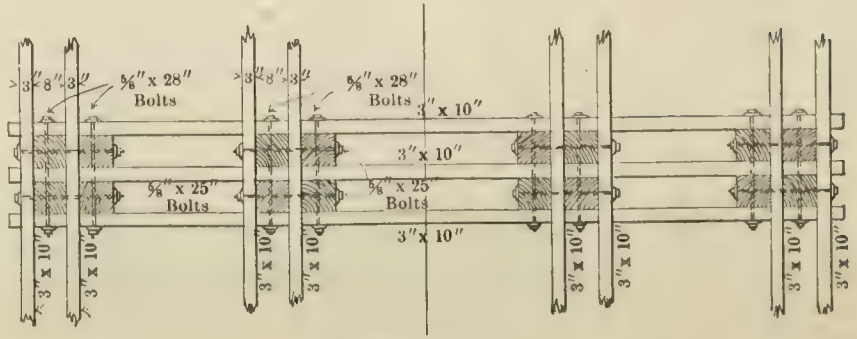


Plan of Top of Bent





Foundation Plan of Bent



Section A—B

proceeds, probably in many cases being alternately more than six inches on one side or the other of the center line of track. To reduce the effect of this action as much as possible, the supports should be as far apart as possible, transversely.

A center pile is not well calculated to help this matter, neither does it add but very little to the lateral stiffness of the bent, and the writer believes that the better practice would be to use five bents of four piles each, rather than four bents of five piles each.

To obtain the same lateral stiffness, no more lateral bracing will be required, for the five four-pile bents would be more rigid laterally without bracing than the four five-pile bents would be. The load on each cap would be less, the stress on the stringers would be less, and no material is added to the structure except one more cap in four.

The dynamic effect of the rolling engine, as well as the effect of the counterweights, would very materially reduce, since they are a function of the rigidity of the floor. The weight would also be better distributed than in the former case.

In short, the writer would recommend the use of four piles in a bent instead of five, and twelve feet of panel length instead of fourteen, except in trestles of considerable height, and he would then quickly pass to the use of six piles instead of five. For high frame construction, the style shown on the accompanying print is recommended.

This is known as the Cluster Bent Trestle, designed by Mr. F. N. Finney, C. E., President of the M., K. & O. R. R. With slight modifications, it can be adapted to circumstances and will give very good results for structures from 40 to 120 feet high. Each post consists of four eight by eight sticks, packed three inches apart, starting at the top with two 15-foot sticks and spliced down with 30-foot sticks till the desired length is reached. A dowel pin is used at the splices and the splices are covered by the girts and the frame rests on double sills. When necessary, any stick except the cap and sill can be replaced from one of these frames without further precaution than a slow order over the structure.

APPENDIX

OFFICERS OF PRELIMINARY ORGANIZATION.

1898-1899.

Chairman.

A. TORREY, Michigan Central Railroad, Detroit, Mich.

Secretary.

L. C. FRITCH, Baltimore & Ohio Southwestern R. R., Washington, Ind.

Committee on Constitution and By-Laws.

J. F. WALLACE, Illinois Central Railroad, Chicago, Ill., Chairman.
THOS. RODD, Pennsylvania Lines, Pittsburg, Pa.
W. G. CURTIS, Southern Pacific Company, San Francisco, Cal.
C. H. HUDSON, Southern Railway, Washington, D. C.
P. ALEX. PETERSON, Canadian Pacific Railway, Montreal, Can.

OFFICERS OF PERMANENT ORGANIZATION.

1899-1900.

President.

J. F. WALLACE, Illinois Central Railroad, Chicago, Ill.

First Vice-President.

P. ALEX. PETERSON, Canadian Pacific Railway, Montreal, Can.

Second Vice-President.

W. G. CURTIS, Southern Pacific Company, San Francisco, Cal.

Secretary.

L. C. FRITCH, Baltimore & Ohio Southwestern R. R., Washington, Ind.

Treasurer.

W. S. DAWLEY, Chicago & Eastern Illinois Railroad, Chicago, Ill.

Directors.

A. TORREY, Michigan Central Railroad, Detroit, Mich.
THOS. RODD, Pennsylvania Lines, Pittsburg, Pa.
F. H. MCGUIGAN, Grand Trunk Railway, Montreal, Canada.
W. K. MCFARLIN, Delaware, Lackawanna & Western R. R., Hoboken, N. J.
HUNTER MCDONALD, Nashville, Chattanooga & St. Louis Ry., Nashville, Tenn.
D. J. WHITTEMORE, Chicago, Milwaukee & St. Paul Ry., Chicago, Ill.

OFFICERS 1900-1901.

President.

J. F. WALLACE, Illinois Central Railroad, Chicago, Ill.

First Vice-President.

P. ALEX. PETERSON, Canadian Pacific Railway, Montreal, Can.

Second Vice-President.

HUNTER MCDONALD, Nashville, Chattanooga & St. Louis Ry., Nashville, Tenn.

Secretary.

L. C. FRITCH, Baltimore & Ohio Southwestern R. R., Washington, Ind.

Treasurer.

W. S. DAWLEY, Chicago & Eastern Illinois Railroad, Chicago, Ill.

Directors.

A. TORREY, Michigan Central Railroad, Detroit, Mich.
THOS. RODD, Pennsylvania Lines, Pittsburg, Pa.
F. H. MCGUIGAN, Grand Trunk Railway, Montreal, Canada.
W. K. MCFARLIN, Delaware, Lackawanna & Western R. R., Hoboken, N. J.
J. KRUTTSCHNITT, Southern Pacific Company, San Francisco, Cal.
D. J. WHITTEMORE, Chicago, Milwaukee & St. Paul Ry., Chicago, Ill.

OFFICERS 1901-1902.

President.

GEO. W. KITTREDGE, Cleveland, Cincinnati, Chicago & St. Louis Railway, Cincinnati, Ohio.

First Vice-President.

HUNTER MCDONALD, Nashville, Chattanooga & St. Louis Ry., Nashville, Tenn.

Second Vice-President.

A. W. SULLIVAN, Illinois Central Railroad, Chicago, Ill.

Secretary.

L. C. FRITCH, Baltimore & Ohio Southwestern R. R., Washington, Ind.

Treasurer.

W. S. DAWLEY, Chicago & Eastern Illinois Railroad, Chicago, Ill.

Directors.

A. TORREY, Michigan Central Railroad, Detroit, Mich.
THOS. RODD, Pennsylvania Lines, Pittsburg, Pa.
F. H. MCGUIGAN, Grand Trunk Railway, Montreal, Canada.
H. F. BALDWIN, Chicago & Alton Railway, Chicago, Ill.
T. F. WHITTELSEY, Toledo & Ohio Central Railway, Toledo, Ohio.
J. KRUTTSCHNITT, Southern Pacific Company, San Francisco, Cal.

OFFICERS 1902-1903.

President.

Geo. W. Kittredge, Cleveland, Cincinnati, Chicago and St. Louis Railway, Cincinnati, Ohio.

First Vice-President.

A. W. Sullivan, Illinois Central Railroad, Chicago, Ill.

Second Vice-President.

Hunter McDonald, Nashville, Chattanooga & St. Louis Railway, Nashville, Tenn.

Secretary.

L. C. Fritch, Baltimore & Ohio Southwestern Railroad, Cincinnati, Ohio. (Office, 1562 Monadnock Block, Chicago, Ill.)

Treasurer.

W. S. Dawley, Chicago & Eastern Illinois Railroad, Chicago, Ill.

Directors.

A. Torrey, Michigan Central Railroad, Detroit, Mich.
Thos. Rodd, Pennsylvania Lines West of Pittsburg, Pittsburg, Pa.
J. Kruttschnitt, Southern Pacific Company, San Francisco, Cal.
T. F. Whittelsey, Toledo Railway & Terminal Co., Toledo, O.
F. H. McGuigan, Grand Trunk Railway, Montreal, Canada.
A. W. Johnston, New York, Chicago & St. Louis Ry., Cleveland, O.

OFFICERS 1903-1904.

President.

HUNTER MCDONALD, Nashville, Chattanooga & St. Louis Railway, Nashville, Tenn.

First Vice-President.

H. G. KELLEY, Minneapolis & St. Louis and Iowa Central Railways, Minneapolis, Minn.

Second Vice-President.

JAMES DUN, Atchison, Topeka & Santa Fe Ry. System, Chicago, Ill.

Secretary.

L. C. FRITCH, 1562 Monadnock Block, Chicago, Ill.
E. H. FRITCH, *Secretary pro tem.*

Treasurer.

W. S. DAWLEY, Chicago & Eastern Illinois Railroad, Chicago, Ill.

Directors.

J. KRUTTSCHNITT, Southern Pacific Company, San Francisco, Cal.
T. F. WHITTELSEY, Toledo Railway & Terminal Co., Toledo, O.
F. H. MCGUIGAN, Grand Trunk Railway, Montreal, Canada.
A. W. JOHNSTON, New York, Chicago & St. Louis Ry., Cleveland, O.
GEO. W. KITTREDGE, Cleveland, Cincinnati, Chicago & St. Louis Railway, Cincinnati, Ohio.
A. W. SULLIVAN, Illinois Central Railroad, Chicago, Ill.

Editor.

W. D. PENCE, Professor of Civil Engineering, Purdue University, Lafayette, Ind.

OFFICERS 1904-1905.

President.

HUNTER MCDONALD, Nashville, Chattanooga & St. Louis Railway, Nashville, Tenn.

First Vice-President.

H. G. KELLEY, Minneapolis & St. Louis and Iowa Central Railways, Minneapolis, Minn.

Second Vice-President.

JAMES DUN, Atchison, Topeka & Santa Fe Ry. System, Chicago, Ill.

Past-President.

J. F. WALLACE, Isthmian Canal Commission, Panama, Canal Zone.

Secretary.

L. C. FRITCH, Illinois Central Railroad, 1562 Monadnock Block, Chicago, Ill.

E. H. FRITCH, *Assistant Secretary.*

Treasurer.

W. S. DAWLEY, Chicago & Eastern Illinois Railroad, Chicago, Ill.

DIRECTORS.

One Year.

F. H. MCGUIGAN, Grand Trunk Railway, Montreal, Canada.

A. W. JOHNSTON, New York, Chicago & St. Louis Ry., Cleveland, O.

Two Years.

GEO. W. KITTREDGE, Cleveland, Cincinnati, Chicago & St. Louis Railway, Cincinnati, Ohio.

A. W. SULLIVAN, Illinois Central Railroad, Chicago, Ill.

Three Years.

WALTER G. BERG, Lehigh Valley Railroad, New York, N. Y.

W. L. BRECKINRIDGE, C., B. & Q. R. R. Chicago, Ill.

EDITOR.

W. D. PENCE, Professor of Civil Engineering, Purdue University, Lafayette, Ind.

CONSTITUTION.

REVISED AT THE FIFTH ANNUAL CONVENTION.

ARTICLE I.

SECTION 1. Name: The name of this Association shall be "THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION."

SECTION 2. Location: The offices of the Association shall be located in Chicago, Ill.

SECTION 3. Object: The object of this Association shall be the advancement of knowledge pertaining to the scientific and economical location, construction, operation and maintenance of railroads.

SECTION 4. Means: The means to be employed for this purpose shall be as follows:

(a) Meetings for the reading and discussion of papers and for social intercourse.

(b) The investigation of matters pertaining to the objects of this Association through Standing and Special Committees.

(c) The publication of papers, reports and discussions.

(d) The maintenance of a library.

ARTICLE II.

MEMBERSHIP.

SECTION 1. The membership of this Association shall be divided into two classes, viz., Active and Honorary.

SECTION 2. Any Civil, Mechanical or Electrical Engineer who has had five (5) years' experience in the location, construction or maintenance of railroads, or a Professor of Engineering in a College of recognized standing, and any railroad official who is responsible for or has supervision of Maintenance of Way (embracing all grades of officials from General Managers to Engineers of Maintenance of Way in charge of Divisions, inclusive), or railroad men bearing other titles but performing similar duties, shall be eligible for Active membership; provided, however, that an applicant, to be eligible for membership, shall be not less than twenty-five (25) years of age.

SECTION 3. An Honorary member shall be a person of acknowledged eminence in railway engineering or management. The number of Honorary members shall be limited to ten. Honorary members shall have all the rights of Active members, except those of voting and holding office.

SECTION 4. Persons who are exclusively engaged in the sale or promotion of railroad patents or appliances shall not be eligible for nor retain Active membership in this Association.

ARTICLE III.

ADMISSIONS AND EXPULSIONS.

SECTION 1. The Charter membership shall consist of all persons who are eligible for membership under the provisions of Article II, and who may make application to the Secretary of the Preliminary Organization and receive a majority of the votes of the Organization Committee (composed of the Chairman and Secretary of the Preliminary Organization and the five persons constituting the Committee to prepare a Constitution and By-Laws), and pay the entrance fee, hereinafter provided for, within thirty days from the date of the adoption of this Constitution.

SECTION 2. After the expiration of said thirty days any person desirous of becoming a member shall make application upon the form prescribed by the Board of Direction, setting forth in a concise statement the candidate's name, age, residence and technical and practical experience. He shall refer to at least three members to whom he is personally known, each of whom shall be requested by the Secretary to certify to a personal knowledge of the candidate and his fitness for membership in the Association. An application shall not be considered by the Board which has not been formally endorsed by three members of the Association.

Upon receipt of an application properly endorsed, the Board of Direction, through its Secretary, or a Committee on Applications to be appointed by the Board of Direction from among its own members, shall make such investigation of the candidate's fitness as may be deemed necessary. The Secretary of the Association will furnish copies of the information obtained, together with a copy of the application, to each member of the Board of Direction. At any time, not less than thirty days after the filing of the application, the admission of the applicant shall be voted on by letter-ballot by each member of the Board of Direction. Affirmative votes by two-thirds of the Board of Direction shall elect the candidate; provided, however, that should an applicant for membership be personally unknown to three members of the Association, due to residence in a foreign country, or in such a portion of the territory of the United States as precludes him from a sufficient acquaintance with members of the Association, he may refer to well-known men engaged in railroad or allied professional work, upon the form above described, and such application shall be considered by the Board of Direction in the manner above set forth, and the applicant may be elected to membership by a unanimous vote of the Board of Direction.

SECTION 3. All candidates, after due notice from the Secretary of their election, shall subscribe to the Constitution and By-Laws on forms

prescribed by the Board of Direction. If this provision be not complied with within six months of said notice, the election shall be considered null and void.

SECTION 4. Any person having once been an Active member of the Association, and having, while in good standing, resigned from such membership, may at a subsequent date be restored to Active membership without the payment of a second entrance fee; provided his application for reinstatement is signed by five members, certifying to his fitness for re-election, and such application is favorably passed upon by the Board of Direction by a two-thirds majority vote of the entire Board.

SECTION 5. Honorary members shall be proposed by at least ten Active members to the Secretary. Each member of the Board of Direction shall be furnished with a copy of the proposal, and after thirty days votes by ballot shall be taken by the Board of Direction thereon. If a candidate shall receive the unanimous vote of said Board, he shall be declared elected an Honorary member.

SECTION 6. Expulsions: On written charges preferred by ten or more members, addressed to the Secretary of the Association, the member complained of shall be served with a copy of said charges, and shall be called upon to show cause to the Board of Direction why he should not be expelled from the Association. Thirty days after said member has been properly notified of the charge preferred against him, a vote shall be taken on his expulsion, and he may be expelled upon a two-thirds vote of the Board of Direction.

SECTION 7. Resignations: It shall be the duty of the Board of Direction to accept the resignation, tendered in writing, of any member whose dues are fully paid up.

ARTICLE IV.

DUES.

SECTION 1. An initiation fee of $10.00 shall be payable to the Secretary with each application for membership; this sum is to be returned to the applicant, however, who is not elected.

SECTION 2. The annual dues of this Association shall be $10.00, payable annually, during the first three months of each calendar year for the current year.

SECTION 3. Any person whose dues remain three months in arrears shall be notified of same by the Secretary. Should the dues in arrears not be paid prior to July 1st of each year, the delinquent member shall lose his right to vote, but shall continue to receive the publications of the Association. Should his dues become nine months in arrears he shall be notified on the form prescribed by the Board of Direction, and he shall no longer receive the publications of the Association. If the delinquent dues are not paid by the first of the following year, he shall forfeit his membership with the Association without further action or notice.

SECTION 4. The Board of Direction may, however, extend the time of payment of dues and for the application of these penalties. The Board of Direction may also, for sufficient cause, excuse from payment the annual dues of any member who, from ill-health, advanced age or other good reason, is unable to pay his dues.

ARTICLE V.

OFFICERS.

SECTION 1. The officers of this Association shall consist of a President, a First Vice-President, a Second Vice-President, six Directors, a Secretary and a Treasurer, who, together with the four latest living Past-Presidents who are Active members, shall constitute the Board of Direction, in which the government of the Association shall be vested, and who shall act as Trustees and have the custody of all property belonging to the Association.

SECTION 2. The term of office of the President and Vice-Presidents shall be two years; that of the Directors three years, and of the Secretary and the Treasurer one year, with the exception, however, that at the first election of officers after the adoption of this Constitution one Vice-President and two Directors shall be elected to serve one year; one Vice-President and two Directors for two years, and two Directors for three years; provided, also, that after the first annual election, one Vice-President and two Directors shall be elected each year, in addition to the President, Secretary and Treasurer.

SECTION 3. The President shall not be eligible for re-election to that office until the period of eight years shall have elapsed after the expiration of his previous term of office. The Vice-Presidents and Directors shall not be eligible for re-election to the same office until at least one full term shall have elapsed after the expiration of their previous term of office.

SECTION 4. The first election of officers under this Constitution shall be held by the Preliminary Organization of Charter members immediately after the adoption of this Constitution, and the officers so elected shall at once assume office. The term of each officer shall begin at the close of each election and shall continue until his successor shall be elected.

SECTION 5. Any vacancy in the office of President shall be filled by the First Vice-President. A vacancy in the office of either of the Vice-Presidents shall be filled by election from among the Directors. In case of the disability or neglect in the performance of his duty of any officers of this Association, the Board of Direction, by a two-thirds majority of the entire Board, shall have power to declare the office vacant. Vacancies in any office for the unexpired term shall be filled by the Board of Direction, except vacancy in the office of President, as provided above.

SECTION 6. At least thirty days before each annual meeting, the Board of Direction, who shall act as a Nominating Committee, shall

nominate to the Association a list of officers for the next ensuing year. At any time prior to the thirty days before the annual meeting any ten members of the Association shall have the right to nominate officers for the ensuing year. Thirty days prior to each annual meeting the Secretary shall issue ballots to each member of record in good standing, with a list of the several candidates to be voted upon, whose names shall be placed in alphabetical order if more than one person is nominated for any position. Ballots shall be placed in a sealed envelope, with the name of the member voting endorsed thereon, and deposited with the Secretary at any time previous to the annual meeting. At the annual meeting three tellers shall be appointed, who shall open and count the ballots and report the result thereof. The majority of votes cast for any nominee shall determine his election.

ARTICLE VI.

COMMITTEES.

SECTION 1. The Board of Direction shall meet within thirty days after each annual meeting, and shall appoint from among its members a Finance Committee of three, a Library Committee of three and a Committee on Publications of three. These Committees shall report to the Board of Direction and perform their duties under its supervision.

SECTION 2. The Finance Committee shall have immediate supervision of the accounts and financial affairs of the Association; shall approve all bills before payment, and shall make recommendations to the Board of Direction as to the investment of moneys and as to other financial matters. The Finance Committee shall not have the power to incur debts or other obligations binding the Association, nor authorize the payment of money other than the amounts necessary to meet ordinary current expenses of the Association, except by previous action and authority of the Board of Direction.

SECTION 3. The Library Committee shall have general supervision of the library of the Association and property therein.

SECTION 4. The Committee on Publications shall have general supervision of the publications of the Association.

SECTION 5. The Board of Direction may appoint such Standing Committees as it may deem best, to investigate, consider and report upon methods or appliances pertaining to the general question of railroad location, construction or maintenance.

It shall be within the province of the Board of Direction to invite discussions of reports from sources outside of the Association from those who are especially qualified by their learning and experience to add to the value of the report under consideration; and such discussions may be printed in the Bulletins prior to the regular annual meeting, and, if approved by the vote of the Association, shall be included in the published Proceedings of the Association.

SECTION 6. Special Committees to examine into and report upon

any subject connected with the purposes of this Association may be appointed in the following manner:

A resolution to appoint such Committee, setting forth its objects and the number of its members, may be presented by letter at any time to the Secretary of the Association, if signed by ten Active members, and shall be referred by him to the Board of Direction, which, if it sees fit, may appoint such Committee. If the Board of Direction should not deem it expedient to appoint such a Committee, the members requesting the appointment of such Committee shall be notified, and the matter will then be referred to the Association at its next annual meeting and decided upon by ballot. If two-thirds of the members present vote in favor of such Committee it shall be appointed by the President.

ARTICLE VII.

MANAGEMENT.

SECTION 1. The President shall have a general supervision of the affairs of the Association. He shall preside at all meetings of the Association and at all meetings of the Board of Direction, and shall be ex-officio member of all Committees.

The Vice-Presidents in order of seniority shall preside at meetings in the absence of the President, and discharge his duties in case of a vacancy in his office.

SECTION 2. The Board of Direction shall manage the affairs of the Association and shall have full power to control and regulate all matters not otherwise provided for in the Constitution.

SECTION 3. The Treasurer shall receive all moneys and deposit same in the name of the Association, and shall receipt to the Secretary therefor. He shall invest all funds not needed for current disbursements as shall be ordered by the Board of Direction. He shall pay all bills, when properly certified and audited by the Finance Committee, and make such reports as may be called for by the Board of Direction.

SECTION 4. The Secretary shall be, under the direction of the President and Board of Direction, the Executive officer of the Association. He shall attend all meetings of the Association and of the Board of Direction, prepare the business therefor, and duly record the proceedings thereof. He shall see that all moneys due the Association are carefully collected and without loss transferred to the custody of the Treasurer. He shall personally certify to the accuracy of all bills or vouchers on which money is to be paid. He is to conduct the correspondence of the Association and keep proper record thereof, and perform such other duties as may be assigned to him from time to time by the Board of Direction.

ARTICLE VIII.

MEETINGS.

SECTION 1. The regular annual meeting of the Association shall be held in the City of Chicago, commencing upon the third Tuesday in

March of each year, and at such place in said city as may be selected by the Board of Direction. Twenty-five Active members shall constitute a quorum. Other meetings of the Association may be held at such times and at such places, either within or without the City of Chicago, as the Board of Direction may select. The Secretary shall notify all members of the time and place of all meetings of the Association at least thirty days in advance thereof.

SECTION 2. The Board of Direction shall meet at such times and at such places as the President may direct. Five members of the Board of Direction shall constitute a quorum.

SECTION 3. The order of business at meetings of the Association shall be as follows:

1. Reading of Minutes of last meeting.
2. Address of the President.
3. Reports of the Secretary and Treasurer.
4. Reports of Standing Committees.
5. Reports of Special Committees.
6. Unfinished business.
7. New business.
8. Election of officers.
9. Adjournment.

This order of business, however, may be varied from on a majority vote of members present at any meeting.

SECTION 4. Discussions shall be limited to members and to those invited to speak by the Presiding Officer.

ARTICLE IX.

AMENDMENTS.

SECTION 1. Proposed amendments to this Constitution must be made in writing and signed by not less than ten Active members, and shall be acted upon in the following manner:

The amendments shall be presented to the Secretary, who shall send a copy of same to each member of the Board of Direction as soon as received. If at the next meeting of the Board of Direction a majority of the Board are in favor of considering the proposed amendments, the matter shall then be submitted by letter to each Active member of the Association for voting by ballot, and the result announced by the Secretary at the next annual meeting of the Association. In case two-thirds of the votes received are affirmative, the amendments shall be declared adopted. Amendments so adopted shall take effect thirty days thereafter.

GENERAL RULES FOR THE PREPARATION OF COMMITTEE REPORTS.

(1) Submit condensed statement of meetings held and names of members in attendance; also personnel of sub-committees appointed for special subjects.

(2) Review briefly last report, describing action taken by the Association thereon, enumerating in their order all conclusions adopted, referring to volume and page of Proceedings. Submit recommendations for changes in previously adopted reports when deemed advisable, and include specifications or standards adopted at the last convention.

(3) Make special effort, by personal request and letters, to secure written discussion of past reports as a guide for future action.

(4) Frame reports to conform as far as possible to the following general plan:

First—Historical.—A brief account of the history of the subject-matter of the report, giving an outline of the origin and development of the same.

Second—Analytical.—An analysis of the subject-matter of the report, especially of the most important elements thereof.

Third—Argument.—A statement giving the advantages in favor of the recommended practices and the disadvantages of the old or present practices.

Fourth—Conclusions.—The final recommendations for the adoption of the various elements of the report in the order of sequence, expressing in succinct language the action which it is desired the convention is to take.

Fifth—Definitions.—Submit definitions of technical terms used in the report, the meaning of which is not clearly established, defining them only from a professional standpoint. Group or tabulate definitions according to their analytical sequence or for convenience of discussion and reference.

Sixth—Plans.—The title of the drawings or plans submitted with reports to be placed in the upper right-hand corner, together with the following lettering:

Am. Ry. Eng. & M. W. Assn.
Convention of 190..
Committee on.....
(Title of drawing.)

(5) The collection and compilation of data and subsequent analysis in the form of arguments and criticism is a necessary and valuable preliminary element of all committee work, but the ultimate aim of all the Association's efforts should be to produce permanent results. This can be best accomplished by having all committee work tend toward the presentation to the Association of concise conclusions, recommendations, specifications, standards, plans, etc., suitable for adoption and recommendation as good practice.

GENERAL RULES FOR CONSIDERATION AND PUBLICATION OF COMMITTEE REPORTS.

(1) No report shall come before the convention for discussion unless it has been published in the Bulletin.

(2) Written discussions on published reports will appear in subsequent Bulletins. The last Bulletin before the convention will appear about February 1st. Discussions received between December 31st and February 15th which do not appear in the last Bulletin will be published in leaflet form. The convention will be held about the middle of March of each year. Discussions received after February 15th will not be published prior to the convention, but will be transmitted to the respective committees as soon as received. Reports for which no definite date for publication has been fixed by the Board of Direction must be presented not later than December 31st. Reports received after December 31st will not come before the following convention for discussion, will be withheld from the public press, published in a Bulletin after the convention, and considered at the next convention.

(3) Reports will be considered by the convention in the order of their publication in the Bulletin, unless the convention by a two-thirds majority may decide to give precedence to one or more particular reports.

(4) No report shall be published in the Proceedings unless it shall have been acted upon by the convention. Reports coming before the convention and not being acted upon for lack of time will be published in subsequent Bulletins, together with all written discussions presented to the Secretary thereon, at times fixed by the Board of Direction.

(5) The method of consideration of reports will be as follows:

(a) Reading by title.
(b) Reading, discussing and acting upon each conclusion separately.
(c) By majority vote discussion will be had of each item. Clauses not objected to when read will be considered as voted upon and adopted.

(6) Action by the convention on reports will be one of the following after discussion is closed:

(a) Receiving as information.
(b) Receiving as a progress report and referring back to committee.
(c) Adoption of a portion and referring remainder back to committee.
(d) Adoption as amended.
(e) Adoption as submitted.

(7) Reports will be published in the Proceedings in their original form, as presented by the committee; but the Secretary will prepare for convenience of reference a summary of the alterations ordered by the Association and insert the same immediately after the signature of the committee and preceding the discussion.

(8) All discussions, both oral and written, will be published in the Proceedings. Each speaker's remarks will be submitted to him in writing

before publication in the Proceedings for correction of diction and errors of reporting, but not for the elimination of remarks.

(9) All committee organizations are to be considered permanent unless changes are made by the Board of Direction.

(10) As soon as possible after each annual convention the Board of Direction will announce the outline of committee work for the next convention, with list of committeemen.

(11) Reports as finally adopted by the Association will be published from time to time in a volume to be entitled *"Manual of Recommended Practice for Railway Engineering and Maintenance of Way,* containing the Definitions, Specifications and Principles of Practice adopted and recommended by the American Railway Engineering and Maintenance of Way Association."

GENERAL RULES FOR PUBLICATION OF "MANUAL OF RECOMMENDED PRACTICE."

(1) The title of the volume will be *"Manual of Recommended Practice for Railway Engineering and Maintenance of Way,* containing the Definitions, Specifications and Principles of Practice adopted and recommended by the American Railway Engineering and Maintenance of Way Association," edited under the direction of the Committee on Publications and publication approved by the Board of Direction.

(2) The adoption by the Association and subsequent publication of any matter in the Manual shall be considered in the nature of *recommended practice* and shall not be binding on the members.

(3) The Manual shall only include resolutions, conclusions, recommendations, plans, etc., relating to definitions, specifications or principles of practice of such questions connected with railway engineering and maintenance of way work which have been made the subject of a special study by a standing or special committee and embodied in a committee report, published not less than thirty days prior to the annual convention, and submitted by the committee at the annual convention, and which, after due consideration and discussion, shall have been voted on and formally adopted by the Association.

(4) Any matter published in the Manual may be amended, revised, extended or withdrawn by vote at any subsequent annual convention, provided such changes are proposed in time for publication not less than thirty days prior to the annual convention, and in the following manner: (a) Upon recommendation of the committee in charge of the subject; (b) upon recommendation of the Board of Direction; (c) upon request of five members.

(5) All resolutions, conclusions, recommendations, specifications, standards, etc., in order to be included in the Manual, must be in concise and proper final shape for publication, as the Manual will consist only of a summary record of the definitions, principles of practice, specifications and standards recommended by the Association, with a brief reference

to the published Proceedings of the Association for the context of the committee report and subsequent discussions and the final action by the Association.

(6) The Board of Direction shall have authority to exclude from the Manual any matter which, in its judgment, it shall consider as not desirable to publish, or as not being in proper shape, or as not having received proper study and consideration.

(7) The Manual will be revised annually and kept up-to-date by publishing a new edition or a supplemental pamphlet as promptly as possible after each annual convention.

INSTRUCTIONS TO COMMITTEES RELATIVE TO THE PUBLICATION OF THE MANUAL OF RECOMMENDED PRACTICE IN 1905.

At the last convention it was decided to publish a Manual of the Recommended Definitions, Specifications and Principles of Practice recommended by the Association, it being understood that the action of the Association in this respect is in the nature of recommendations only and not binding on its members.

Owing to the importance and weight that should justly be attributed to the deliberate and carefully expressed opinion of an Association comprising prominent railway officials and specialists in the various classes of work and duties connected with the location, construction, maintenance and operation of railroads, and the influence that this publication will have on railway engineering and maintenance of way work in this country by systematizing the work and establishing recommended standards of practice, the Board of Direction desires to exercise particular care to include in the Manual only such matter as has been carefully and sufficiently considered by the Association prior to its adoption by vote at the annual conventions, so as to warrant its publication in the Manual as the practice endorsed and recommended by the Association.

The Board has adopted "General Rules for Publication of the Manual of Recommended Practice," which are presented herewith and which will be submitted to the Association for adoption at the next convention. In the interim these rules will govern the preparation of the draft of the first issue of the Manual, which will be submitted for approval at the next convention, with the idea of publishing the first issue of the Manual next year.

The work of the committees for the current year should concentrate largely on perfecting data for publication in the "Manual of Recommended Practice." The attention of all the committees is called to the necessity of carefully reviewing the work of their respective committees during the last five years, with a view to utilizing any information and data worked up and presented heretofore, but which, owing to its imperfect shape and absence of precise conclusions or recommendations, has not been acted on, or while, in many cases, the record indicates that the report may have been adopted, such general action does not allow the report to

be embodied in the Manual for the reasons mentioned, but which data, if revised, condensed and presented in concise shape, might prove valuable for recording in the Manual.

The committees should further carefully examine the draft of the Manual as preliminarily established by the Board of Direction, a copy of which will be sent to each committee, as also the synopsis of the draft of the Manual, taking such steps as may seem desirable and as may be indicated by the Board to insure that the first issue of the Manual will embody correctly such sections or action of previous committee reports as have been sufficiently and carefully considered and adopted and are in such final shape as to warrant recording same in the Manual.

In this same connection committees should endeavor to supplement any missing parts or sections of specifications, definitions or recommended practice heretofore adopted and scheduled for reproduction in the Manual, yet which could be improved by re-editing, supplementing and rounding out so as to offer a more complete and finished presentation of the subject in question.

The Board of Direction cannot undertake to give specific instructions in the above respects to the various committees, but believes that the above general outline will serve to indicate the trend of the special work the Board desires undertaken, with a view to making the first issue of the Manual of Recommended Practice a success and less liable to future revision.

INSTRUCTIONS TO COMMITTEES—OUTLINE FOR 1904-1905.

The Board of Direction is considering the question of whether the original outline of committee work, as adopted in 1900, should be followed, or whether same should be replaced by special instructions yearly by the Board of Direction, and has reached the conclusion that, for the present, the original outline be considered as governing the scope of each committee's work in the absence of other instructions from the Board.

In the following instructions the Board has outlined the important points which, in its judgment, each committee should preferably consider during the current year, but the Board does not desire to prevent any committee from presenting the results of any special study or investigation it may be now engaged on or that it considers important to take up at the next convention.

GENERAL FOR ALL COMMITTEES.

Review, revise and supplement, if thought desirable, all matter adopted heretofore and considered suitable for publication in the "Manual of Recommended Practice." Indicate in the report of the committee what material changes, if any, the committee would recommend making in previously adopted versions. Revise and retabulate all definitions (see clause 5 of General Rules for Preparation of Committee Reports).

I. ROADWAY.—Revise Specifications for Construction of Roadway, as published in Bulletin No. 48, and explain important corrections made in articles 1 to 68, as adopted in 1903. Prepare an overhaul clause for use as an alternate clause in Specifications for Construction of Roadway. Standard cross-sections of roadway. Methods of Grade Reduction.

II. BALLASTING.—Prepare concise general requirements or specifications, with marginal index, for preparation and delivery of various kinds of ballast. General conclusions relative to ballast, similar to 1903 report (Bulletin No. 46, page 28). Confer with Track Committee relative to ballast cross-sections. Recommendation as to best and most economical method of furnishing standard stone ballast to cover quarrying, crushing and delivery along roadway.

III. TIES.—Revise general specifications for ties, with marginal index. Definition of tie. Concise rules for marking ties, as defined in general in President's circular letter of November 12, 1902. Supplemental data and statistics relative to life of ties and preservative processes. Collect data as to sizes of ties in use. Confer with Track Committee and make recommendations as to tie spacing and sizes of ties for various conditions.

IV. RAIL.—Frequency of occurrence, cause and remedy for piped rails. Prepare list of definitions. Recommendation as to limiting number of standard rail sections. Statistics as to life of rails. Confer with Track Committee, if considered desirable, to revise recommendation relative to standard drilling. Confer with Track Committee on general requirements of a standard rail joint.

V. TRACK.—Revise and present in precise final shape Maintenance of Line and Maintenance of Surface, as adopted in 1902 and modified in 1904 (Bulletin No. 46, pages 56 to 60); Maintenance of Gauge, adopted in 1904. Revise and submit for adoption Inspection of Track and Tools (1902 report, pages 60 to 66). Definition of gauge of track. Revise recommendation relative to standard drilling, if thought desirable, conferring with Rail Committee. Confer with Rail Committee and present conclusions relative to general requirements of standard rail joint. Confer with Tie Committee relative to tie spacing and sizes of ties for various conditions. Confer with Ballasting Committee relative to ballast cross-sections.

VI. BUILDINGS.—Standard form of contract for railroad buildings. Recommendation relative to one general waiting room or separate waiting rooms in local passenger stations, without reference to separate waiting rooms for colored people. Recommendations relative to the requirements of a modern roundhouse.

VII. WOODEN BRIDGES AND TRESTLES.—Prepare standard plans and general specifications for single and double track pile and frame trestles on tangent and curves, for various heights and conditions. Recommendations as to economy and advisability of ballasted deck trestles, with and without treated timber.

VIII. MASONRY.—Revise, if necessary, specifications for Portland Cement, Natural Cement and Portland Cement Concrete. Present specification clauses for sand test and for standard sand. Recommendations relative to classification of masonry. Specification clauses for tests for soundness of cement and recommendations as to conditions under which such tests are desirable. Recommendations as to efficiency of concrete backing for stone face-work, as to bedding large stones in interior of heavy concrete structures, and as to use of concrete under bridge seats in place of stone pedestals. Economy and advisability of substituting reinforced concrete for the common forms of construction for small openings. Co-operate with the Special Committee of the American Society of Civil Engineers appointed to report on concrete and reinforced concrete.

IX. SIGNS, FENCES, CROSSINGS AND CATTLE-GUARDS.—Specifications for fences, with marginal index. Report on galvanizing wire. Report on breaking strength of wire.

X. SIGNALING AND INTERLOCKING.—Revise and present in concise final shape recommendations relative to train-order signals and compensation of pipe lines, as adopted in 1903. Prepare list of general definitions relating to signaling and interlocking, such definitions not to conflict with the rulings of the American Railway Association, and to correspond, as far as possible, with the practice adopted by the Railway Signal Association. Manually-controlled block signaling. Specifications for interlocking plants. Method of protecting railroad grade crossings other than by interlocking.

XI. RECORDS, REPORTS AND ACCOUNTS.—System of office records of bridges and culverts on maintenance of way. General labor report or timebook form. Report forms for track foremen. Confer with American Association of Railway Accounting Officers and report relative to desirability of the American Railway Engineering and Maintenance of Way Association considering the question of the proper subdivision of maintenance of way accounts.

XII. UNIFORM RULES, ORGANIZATION, TITLES, CODE, ETC.—Outline for rules and regulations governing employés in the Maintenance of Way Department, giving principal divisions of the subject and list of items to be covered under each head. Recommendation as to whether it would be feasible to establish a set of standard rules embodying general rules and a series of alternate clauses or sections for the various conditions and types of railroad organizations.

XIII. WATER SERVICE.—Water softening methods and plants for various conditions. Comparison of cost of softening plants and operating expenses as compared with benefits derived, and recommendation as to general conditions under which the installation of a plant would produce savings. Solution of problems mentioned in last report, where necessary to reach proper conclusions regarding above outline of work.

XIV. YARDS AND TERMINALS.—Hump and gravity yards. Recommendation as to linear feet of track to assume in rating car standing capacity of yard tracks. Recommendation as to spacing and grouping of tracks in car repair yards and team delivery tracks.

XV. IRON AND STEEL STRUCTURES.—Revise specifications previously adopted for material and workmanship, if deemed necessary. Submit specifications for details of design, and continue investigation of impact, reaming and bending tests. Uniform loading.

XVI. ECONOMICS OF RAILWAY LOCATION.—The Committee to consider all questions connected with railway location, grades, lines and improvements of grades and line affecting the economic operation with relation to traffic, tonnage ratings, speed, density of traffic and financial considerations. The special aim of the Committee should be to establish uniform methods and unit values for investigating and analyzing the relative advantages and costs of comparative routes or proposed grade reductions and line corrections. The outline of work for the current year to be: Review existing literature. Collect data and outline program for studying the subject systematically. Supplement with such investigations and arguments as thought desirable.

ORGANIZATION OF COMMITTEES FOR 1904-1905.

I. ROADWAY.

H. J. Slifer, General Superintendent, C., R. I. & P. Ry., Chicago, *Chairman.*

R. C. Barnard, Superintendent, C., A. & C. Ry., Akron, O., *Vice-Chairman.*

Geo. H. Bremner, Engineer Ill. Lines, C., B. & Q. R. R., Chicago, Ill.

C. Dougherty, Superintendent, Illinois Central Railroad, Clinton, Ill.

W. I. Lee, Assistant Engineer, Seaboard Air Line, Cedartown, Ga.

W. D. Pence, Professor of Civil Engineering, Purdue University, Lafayette, Ind.

H. C. Phillips, Chief Engineer, S. F. & N. W. Ry., San Francisco, Cal.

H. Rohwer, Chief Engineer, Missouri-Pacific Ry., St. Louis, Mo.

A. M. Shaw, Chief Engineer, Northern Illinois Electric Railway, Dixon, Ill.

A. K. Shurtleff, Assistant Engineer, Union Pacific Railroad, Omaha, Neb.

F. L. Stuart, Engineer of Surveys, Baltimore & Ohio Railroad, Baltimore, Md.

H. M. Waite, Superintendent, Cincinnati, New Orleans & Texas Pacific Ry., Lexington, Ky.

II. BALLASTING.

John V. Hanna, Prin. Assistant Engineer, St. Louis & San Francisco Railway, St. Louis, Mo., *Chairman.*

C. A. Paquette, Superintendent, C., C., C. & St. L. Ry., Indianapolis, Ind., *Vice-Chairman.*

C. H. Byers, Division Engineer, Kansas City Southern Ry., Pittsburg, Kan.

A. Q. Campbell, Hogansville, Ga.

L. F. Goodale, Engineer M. of Way, C., B. & Q. R. R., St. Louis, Mo.

G. D. Hicks, Superintendent, N. C. & St. L. Ry., Tullahoma, Tenn.

B. C. Milner, Superintendent, Southern Railway, Louisville, Ky.

J. O. Osgood, Chief Engineer, Cen. R. R. of N. J., Jersey City, N. J.

F. W. Ranno, Engineer M. of Way, Southern Indiana Ry., Terre Haute, Ind.

Samuel Rockwell, Prin. Asst. Engineer, L. S. & M. S. Ry., Cleveland, O.

J. G. Sullivan, Division Engineer, Can. Pac. Ry., Winnipeg, Manitoba.

III. TIES.

E. B. Cushing, Gen. Supt., La. Lines, Southern Pacific Company, New Orleans, La., *Chairman.*

W. W. Curtis, Consulting Engineer, Chicago, *Vice-Chairman.*

O. M. Dunn, Superintendent, Illinois Central R. R., New Orleans, La.

C. F. W. Felt, Chief Engineer, G., C. & S. F. Ry., Galveston, Texas.
E. Ford, Superintendent, V., S. & P. Ry., Vicksburg, Miss.
R. R. Hammond, Second Vice-President, St. L. & S. F. Ry. System, St. Louis, Mo.
E. E. Hart, Engineer, N. Y., C. & St. L. Ry., Cleveland, O.
F. T. Hatch, Superintendent, Vandalia Line, Terre Haute, Ind.
J. C. Nelson, Roadmaster, Alabama Great Southern Railway, Birmingham, Ala.
W. B. Poland, Superintendent, B. & O. S. W. R. R., Cincinnati, O.
S. M. Rowe, Consulting Engineer, Chicago, Ill.
H. R. Safford, Prin. Assistant Engineer, Illinois Central Railroad, Chicago, Ill.

IV. RAIL.

W. R. Webster, Consulting and Inspecting Engineer, Philadelphia, Pa., *Chairman.*
R. Montfort, Chief Engineer, Louisville & Nashville Railroad, Louisville, Ky., *Vice-Chairman.*
F. E. Abbott, Inspecting Engineer, Illinois Steel Company, Chicago, Ill.
G. Bouscaren, Consulting Engineer, Cincinnati, O.
S. M. Felton, President, Chicago & Alton Ry., Chicago, Ill.
Robert W. Hunt, Consulting Engineer, Chicago, Ill.
H. T. Porter, Chief Engineer, Bessemer & Lake Erie Railroad, Greenville, Pa.
Jos. T. Richards, Chief Engineer M. of W., P. R. R., Philadelphia, Pa.
Robert Trimble, Chief Engineer M. of W., N. W. Sys., Penna. Lines, Pittsburg, Pa.
G. B. Woodworth, Rail Inspector, C. M. & St. P. Ry., Chicago, Ill.

V. TRACK.

Garrett Davis, Prin. Asst. Engineer, C., R. I. & P. Ry., Chicago, Ill., *Chairman.*
E. H. Lee, Engineer and General Roadmaster, C. & W. I. Ry., Chicago, *Vice-Chairman.*
Wm. Ashton, Chief Engineer, Oregon Short Line, Salt Lake City, Utah.
J. R. W. Davis, Engineer M. of Way, Great Northern Ry., St. Paul, Minn.
T. H. Hickey, Roadmaster, Michigan Central R. R., St. Thomas, Ont.
C. B. Hoyt, Chief Supervisor of Tracks, N. Y., C. & St. L. Ry., Bellevue, Ohio.
D. MacPherson, Division Engineer, Can. Pac. Ry., Montreal, Canada.
F. L. Nicholson, Engineer M. of Way, Norfolk & Southern Ry., Norfolk, Va.
L. S. Rose, Engineer M. of Way, C., C., C. & St. L. Ry., Mattoon, Ill.
J. C. Sesser, Assistant Engineer, C., B. & Q. Ry., Fulton, Ill.
F. S. Stevens, Superintendent, Philadelphia & Reading Ry., Reading, Pa.

VI. BUILDINGS.

A. R. RAYMER, Assistant Chief Engineer, P. & L. E. Ry., Pittsburg, Pa., *Chairman.*
E. DB. BROWN, Architect, Lehigh Valley Railroad, New York, *Vice-Chairman.*
B. C. GOWEN, Chief Engineer, Wis. & Mich. R. R., Peshtigo, Wis.
R. L. HUNTLEY, Prin. Assistant Engineer, Union Pacific R. R., Omaha, Neb.
E. C. MACY, Prin. Assistant Engineer, Chicago Great Western Railway, St. Paul, Minn.
L. D. SMITH, Building Supervisor, G., C. & S. F. Ry., Galveston, Texas.
H. M. STEELE, Chief Engineer, Central of Georgia Ry., Savannah, Ga.

VII. WOODEN BRIDGES AND TRESTLES.

I. O. WALKER, Assistant Engineer, N. C. & St. L. Ry., Paducah, Ky., *Chairman.*
F. E. SCHALL, Bridge Engineer, Lehigh Valley Railroad, South Bethlehem, Pa., *Vice-Chairman.*
F. H. BAINBRIDGE, Superintendent of Bridges, Illinois Central Railroad, Chicago.
D. B. DUNN, Division Engineer, Seaboard Air Line, Atlanta, Ga.
H. G. FLEMING, Prest. and Chief Engineer, Memphis Belt Railway, Memphis, Tenn.
B. W. GUPPY, Bridge Engineer, Maine Central Railroad, Portland, Me.
J. C. HAUGH, Resident Engineer, N. O. & N. E. R. R., New Orleans, La.
H. S. JACOBY, Prof. of Bridge Engineering, Cornell University, Ithaca, N. Y.
C. C. MALLARD, Asst. Supt., La. & W. R. R., Lafayette, La.
A. S. MARKLEY, Supt. B. & B., C. & E. I. R. R., Danville, Ill.
F. C MILLER, Resident Engineer, Southern Pacific Co., Sacramento, Cal.
F. J. STIMSON, Engineer M. of Way, Grand Rapids & Indiana Railway, Grand Rapids, Mich.
JOB TUTHILL, Bridge Engineer, Pere Marquette Ry., Detroit, Mich.

VIII. MASONRY.

E. C. BROWN, Engineer M. of Way, Union R. R., Port Perry, Pa., *Chairman.*
JOHN DEAN, Civil Engineer, Chicago, *Vice-Chairman.*
C. W. BOYNTON, Chief Insp. Cement Dept., Illinois Steel Co., Austin, Ill.
W. W. COLPITTS, Assistant Chief Engineer, K. C., M. & O. Ry., Kansas City, Mo.
A. O. CUNNINGHAM, Bridge Engineer, Wabash Railroad, St. Louis, Mo.
W. B. HANLON, District Engineer, Baltimore & Ohio R. R., Cleveland, O.
C. M. MILLS, Prin. Asst. Engineer, Elev. R. R. and Subway, Philadelphia, Pa.
H. W. PARKHURST, Engineer B. & B., Illinois Central Railroad, Chicago.

A. F. Robinson, Bridge Engineer, Santa Fe Ry. System, Chicago, Ill.
J. W. Schaub, Consulting Engineer, Chicago.
G. F. Swain, Professor of Civil Engineering, Mass. Inst. of Technology, Boston, Mass.
E. P. Weatherly, Resident Engineer, H. & St. J. Ry., St. Joseph, Mo.

IX. SIGNS, FENCES, CROSSINGS AND CATTLE-GUARDS.

A. S. Baldwin, Engineer of Construction, Illinois Central Railroad, Chicago, *Chairman.*
E. G. Ericson, Prin. Asst. Engineer, Penna. Lines, Pittsburg, Pa., *Vice-Chairman.*
C. H. Ewing, Division Engineer, Phila. & Reading Ry., Reading, Pa.
S. B. Fisher, Chief Engineer, M., K. & T. Ry., St. Louis, Mo.
F. P. Gutelius, Engineer M. of Way, Can. Pac. Ry., Montreal, Canada.
T. L. Hanley, Asst. Engineer, Grand Trunk Ry., Grand Rapids, Mich.
J. C. Hechler, Roadmaster, Colorado Midland Ry., Colorado City, Colo.
F. G. Jonah, Chief Engineer, St. L., B. & M., Ry., Corpus Christi, Texas.
A. G. Norton, Inspector Eng. Dept., B. & O. R. R., Washington, D. C.
S. D. Pugh, Eng. Dept., C., R. I. & P. Ry., Chicago.
F. A. Smith, Editor, *Roadmaster and Foreman*, Chicago, Ill.
W. D. Williams, Chief Engineer, Cincinnati Northern Railway, Van Wert, O.

X. SIGNALING AND INTERLOCKING.

J. C. Mock, Signal Engineer, Michigan Central Railroad, Detroit, Mich., *Chairman.*
W. C. Cushing, Chief Engineer M. of Way, S. W. Sys., Penna. Lines, Pittsburg, Pa., *Vice-Chairman.*
C. L. Addison, Gen. Supt. Trans., Long Island R. R., Long Island City, N. Y.
F. H. Alfred, Chief Engineer, Pere Marquette R. R., Detroit, Mich.
Chas. Dunham, Signal Engineer, Illinois Central Railroad, Chicago.
Lawrence Griffith, Engineer M. of Way, N. Y. C. & H. R. R. R., New York.
A. H. Rudd, Asst. Signal Engineer, P. R. R., Philadelphia, Pa.
W. A. D. Short, Supt. Signals, C., N. O. & T. P. Ry., Lexington, Ky.
Thos. S. Stevens, Signal Engineer, Santa Fe Ry. System, Topeka, Kan.
J. E. Taussig, Superintendent and Supt. Telegraph, Wheeling & Lake Erie R. R., Canton, O.

XI. RECORDS, REPORTS AND ACCOUNTS.

Edwin F. Wendt, Assistant Engineer, Pittsburg & Lake Erie Railroad, Pittsburg, Pa., *Chairman.*
W. S. Kinnear, Chief Engineer, Michigan Central Railroad, Detroit, Mich., *Vice-Chairman.*
W. Archer, B. & O. S. W. R. R., Cincinnati, O.

J. G. Bloom, Prin. Asst. Engineer, C., R. I. & P. Ry., Chicago, Ill.
H. Fernstrom, Chief Engineer, N. Y. C. & H. R. R. R., New York.
V. K. Hendricks, Asst. Engineer M. of Way, Baltimore & Ohio Railroad, Baltimore, Md.
Paul Jones, Engineer M. of Way, Penna. Lines, Columbus, O.
B. S. Josselyn, General Manager, Union Terminal Ry., Philadelphia, Pa.
W. S. Thompson, Asst. Engineer, Pennsylvania Railroad, Oil City, Pa.
J. E. Turk, Superintendent, Philadelphia & Reading Railway, Tamaqua, Pa.
E. K. Woodward, Engineer M. of Way, Wabash Railroad, Detroit, Mich.
H. A. Woods, Assistant Engineer, Grand Trunk Railway, Detroit, Mich.

XII. UNIFORM RULES, ORGANIZATION, TITLES, CODE, ETC.

R. H. Aishton, Assistant General Manager, C. & N. W. Ry., Chicago, *Chairman.*
W. L. Derr, Chief Engineer, Erie Railroad, New York, *Vice-Chairman.*
J. H. Abbott, Chief Engineer, Cleveland Belt Ry., Cleveland, O.
C. N. Kalk, Chief Engineer, Wis. Cen. Ry., Milwaukee, Wis.
C. S. Millard, Engineer M. of Way, Peoria & Eastern Ry., Indianapolis, Ind.
H. G. Prout, Vice-Prest. and General Manager, U. S. & S. Co., Swissvale, Pa.
R. O. Rote, Second Asst. Engineer, L. S. & M. S. Ry., Cleveland, O.
H. J. Simmons, General Supt. El Paso & S. W. Ry., El Paso, Texas.
A. G. Trippeer, Engineer M. of Way, Wabash R. R., Moberly, Mo.
H. U. Wallace, Chief Engineer, Illinois Central Railroad, Chicago.
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456. YAMAGUCHI, JUNNOSUKE,
Chief Engineer, Sanyo Railway, Kobe, Japan.

Z

207. ZIESING, A.,
Western Manager, American Bridge Co., Chicago, Ill.

476. ZINCK, K. J. C.,
Division Engineer, Chicago, Rock Island & Pacific Railway, Des Moines, Iowa.

HONORARY MEMBER.

SHEPARD, D. C.,
Minneapolis, Minn.

DECEASED MEMBERS.

BURKE, S. E.
CAFFREY, RICHARD.
CLARK, J. M.
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CASEY, D. J.
COLLINS, E. M.
CURTIS, W. G.
DRAPER, H. C.
FREY, J. J.
GARDNER, G. W.
GOODE, J. V.
HALL, FERDINAND.
KELLOGG, E. A.
KIDDER, J. F.
KLINE, THEO. D.
MAHL, J. T.
MORISON, G. S.
O'MELVENY, J. C.
QUINLAN, G. A.
SCHMIDT, H. W.
TAYLOR, J. W.
TORREY, A.
WIGHT, R. H.

MEMBERSHIP AND MILEAGE OF RAILWAYS REPRESENTED IN THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION

Name of Road and Membership.	Members.	Mileage.
Ann Arbor Railroad	1	292
O. D. Richards, Toledo, Ohio.		
Argentine Republic Railways	1	
G. F. T. Dominico, Buenos Ayres, Arg. Rep.		
Atchison, Topeka & Santa Fe Railway	7	5,031
James Dun, Chicago, Ill.		
W. B. Storey, Jr., Topeka, Kan.		
A. F. Robinson, Chicago, Ill.		
C. A. Morse, Topeka, Kan.		
T. S. Stevens, Topeka, Kan.		
F. M. Bisbee, La Junta, Col.		
G. W. Vaughn, Chicago, Ill.		
Gulf, Colorado & Santa Fe Railway	3	1,127
C. F. W. Felt, Galveston, Texas.		
J. C. Christy, Temple, Texas.		
L. D. Smith, Galveston, Texas.		
Baltimore & Ohio Railroad	13	4,410
C. S. Sims, Baltimore, Md.		
L. G. Haas, Baltimore, Md.		
D. D. Carothers, Baltimore, Md.		
J. E. Greiner, Baltimore, Md.		
W. B. Hanlon, Cleveland, Ohio.		
F. L. Stuart, Baltimore, Md.		
Paul Didier, Allegheny, Pa.		
V. K. Hendricks, Baltimore, Md.		
A. G. Norton, Washington, D. C.		
C. E. Bryan, Parkersburg, W. Va.		
L. G. Curtis, Chicago, Ill.		
J. T. Wilson, Wheeling, W. Va.		
H. R. Talcott, Cumberland, Md.		
Baltimore & Ohio Southwestern Railroad	4	918
W. B. Poland, Cincinnati, Ohio.		
W. Archer, Cincinnati, Ohio.		
Earl Stimson, Washington, Ind.		
L. F. Boeh, Cincinnati, Ohio.		
Brunswick & Birmingham Railroad	1	220
Alex. Bonnyman, Brunswick, Ga.		
Bessemer & Lake Erie Railroad	2	216
H. T. Porter, Greenville, Pa.		
E. J. Randall, Greenville, Pa.		

Name of Road and Membership.	Members.	Mileage.
Boston & Albany Railroad	1	392
Walter Shepard, Boston, Mass.		
Boston & Maine Railroad	1	2,293
J. P. Snow, Boston, Mass.		
Buffalo & Susquehanna Railroad	2	172
H. Herden, Galeton, Pa.		
H. C. Landon, Galeton, Pa		
Buffalo, Attica & Arcade Railway	1	28
S. S. Bullis, Olean, N. Y.		
Buffalo, Rochester & Pittsburg Railway	1	475
J. M. Floesch, Rochester, N. Y.		
Burlington Route	8	8,225
Chicago, Burlington & Quincy.		
D. Willard, Chicago, Ill.		
F. A. Delano, Chicago, Ill.		
W. L. Breckinridge, Chicago, Ill.		
G. H. Bremner, Chicago, Ill.		
John C. Sesser, Fulton, Ill.		
Burlington's Missouri Lines.		
L. F. Goodale, St. Louis, Mo.		
F. M. Patterson, Moscow Mills, Mo.		
E. P. Weatherly, St. Joseph, Mo.		
California & Northwestern Railway	1	190
J. L. Frazier, San Francisco, Cal.		
Cammal & Black Forest Railroad	1	31
C. B. McCullough, Jersey Shore, Pa.		
Canadian Northern Railway	1	1,350
H. F. Forrest, Winnipeg, Man.		
Canadian Pacific Railway	10	8,322
P. Alex. Peterson, Montreal, Canada,		
J. W. Leonard, Winnipeg, Man.		
W. F. Tye, Montreal, Canada.		
F. P. Gutelius, Montreal, Canada.		
G. H. Webster, Vancouver, B. C.		
D. MacPherson, Montreal, Canada.		
J. G. Sullivan, Winnipeg, Man.		
A. L. Buck, Montreal, Canada.		
J. M. Dixon, Rat Portage, Ont.		
M. P. Cotton, Winnipeg, Man.		
Central of Georgia Railway	1	1,867
Henry M. Steele, Savannah, Ga.		
Central Railroad of New Jersey	3	685
W. G. Besler, New York, N. Y.		
Jos. O. Osgood, Jersey City, N. J.		
A. L. Bowman, New York, N. Y.		

Name of Road and Membership.	Members.	Mileage.
Central Vermont Railway	2	531
E. H. Fitzhugh, St. Albans, Vt.		
J. M. Morrison, St. Albans, Vt.		
Chesapeake & Ohio Railway	2	1,665
F. W. Scarborough, Richmond, Va.		
H. Pierce, Ronceverte, W. Va.		
Chicago & Alton Railway	1	908
S. M. Felton, Chicago, Ill.		
Chicago & Northwestern Railway	3	7,363
W. A. Gardner, Chicago, Ill.		
R. H. Aishton, Chicago, Ill.		
G. M. Davidson, Chicago, Ill.		
Chicago & Western Indiana Railway	1	49
E. H. Lee, Chicago, Ill.		
Chicago Great Western Railway	3	1,321
E. C. Macy, St. Paul, Minn.		
A. E. Harvey, Ft. Dodge, Iowa.		
H. B. Merriam, Dubuque, Iowa.		
Chicago, Indianapolis & Louisville Railroad	2	271
A. S. Kent, Chicago, Ill.		
W. A. Wallace, Chicago, Ill.		
Chicago Junction Railway	1	271
J. B. Cox, Chicago, Ill.		
Chicago, Milwaukee & St. Paul Railway	5	7,080
H. R. Williams, Chicago, Ill.		
D. J. Whittemore, Chicago, Ill.		
J. B. Moll, Chicago, Ill.		
C. F. Loweth, Chicago, Ill.		
G. B. Woodworth, Chicago, Ill.		
Chicago, Peoria & St. Louis Railway	1	289
J. P. Ramsey, St. Louis, Mo.		
Chicago, Rock Island & Pacific Railway	11	4,354
H. J. Slifer, Chicago, Ill.		
W. L. Darling, Chicago, Ill.		
H. F. White, Chicago, Ill.		
M. L. Byers, Chicago, Ill.		
A. D. Page, Chicago, Ill.		
Garrett Davis, Chicago, Ill.		
J. G. Bloom, Chicago, Ill.		
W. H. Davisson, Chicago, Ill.		
K. J. C. Zinck, Des Moines, Iowa.		
S. D. Pugh, Chicago, Ill.		
C. S. Ells, Atlantic, Iowa.		
Choctaw, Oklahoma & Gulf Railroad	1	
F. O. Melcher, Little Rock, Ark.		
Chicago Union Tranfer Railway	1	100
M. E. Shire, Chicago, Ill.		

Name of Road and Membership.	Members.	Mileage.
Chicago Terminal Transfer Railroad J. N. Faithorn, Chicago, Ill. F. E. Paradis, Chicago, Ill.	2	259
Cincinnati, Hamilton & Dayton Railway C. A. Wilson, Cincinnati, O. I. F. White, Hamilton, Ohio.	2	934
Cincinnati Northern Railroad W. D. Williams, Van Wert, Ohio.	1	236
Cleveland, Cincinnati, Chicago & St. Louis Railway Geo. W. Kittredge, Cincinnati, O. O. E. Selby, Cincinnati, Ohio. Hadley Baldwin, Mattoon, Ill. C. A. Paquette, Indianapolis, Ind. H. H. Knowlton, Indianapolis, Ind. L. S. Rose, Mattoon, Ill. R. H. Simpson, Greensburg, Ind. Robt. H. Moore, Mt. Carmel, Ill.	8	2,290
Peoria & Eastern Railway J. A. Barnard, Indianapolis, Ind. M. A. Neville, Indianapolis, Ind. Chas. S. Millard, Indianapolis, Ind.	3	341
Cleveland Belt Railway. J. H. Abbott, Cleveland, Ohio.		
Cleveland, Akron & Columbus Railway R. C. Barnard, Akron, Ohio.	1	214
Colorado & Southern Railroad H. W. Cowan, Denver, Col.	1	1,144
Colorado Midland Railway J. C. Hechler, Colorado City, Colo.	1	336
Columbia & Southern Railroad A. E. Hammond, Shaniko, Ore.	1	70
Davenport, Rock Island & Northwestern Railway Chas. E. Sheriff, Davenport, Iowa.	1	53
Delaware, Susquehanna & Schuylkill Railroad Edgar Kudlich, Drifton, Pa.	1	76
Denver, Enid & Gulf Railway Ed. L. Peckham, Enid, Okla.	1	57
Detroit & Mackinac Railroad H. S. Waterman, East Tawas, Mich.	1	334
Detroit Southern Railroad Geo. Crocker, Springfield, Ohio.	1	422

Name of Road and Membership.	Members.	Mileage.
Detroit United Street Railways J. C. Hutchins, Detroit, Mich.	1	
Duluth, Missabe & Northern Railroad W. A. McGonagle, Duluth, Minn.	1	34
El Paso & Southwestern Railway H. J. Simmons, El Paso, Texas.	1	340
Erie Railroad F. D. Underwood, New York, N. Y. J. C. Stuart, New York, N. Y. W. L. Derr, New York, N. Y. James Burke, Jersey City, N. J. R. S. Parsons, Cleveland, O. W. H. Peddle, Jersey City, N. J.	6	2,153
Esquimalt & Nanaimo Railway Jos. Hunter, Victoria, B. C.	1	80
Evansville & Terre Haute Railway E. H. Pfafflin, Evansville, Ind. F. R. Puder, Evansville, Ind.	2	162
Ferro-carril Occidental de Guatemala J. B. Hatch, San Felipe, Guat., C. A.	1	52
Fonda, Johnstown & Gloversville Railroad F. A. Bagg, Gloversville, N. Y.	1	33
Grand Rapids & Indiana Railroad F. J. Stimson, Grand Rapids, Mich.	1	620
Grand Trunk Railway F. H. McGuigan, Montreal, Canada. W. McNab, Montreal, Canada. M. S. Blaiklock, Montreal, Canada. H. A. Woods, Detroit, Mich. T. L. Hanley, Grand Rapids, Mich. J. W. Higgins, London, Ont.	6	4,182
Great Northern Railway J. R. W. Davis, St. Paul, Minn. R. C. St. John, Grand Forks, N. D.	2	5,984
Guatemala Central Railway D. B. Hodgsdon, Guatemala City, Guatemala, C. A.	1	143
Halifax & Southwestern Railway L. H. Wheaton, Chester, N. S.	1	74
Hocking Valley Railroad Wm. Michel, Columbus, Ohio.	1	346
Hokkaido Tanko Railway of Japan T. Ohmra, Iwanizawa, Japan.	1	207

Name of Road and Membership.	Members.	Mileage.
Hoshu Railway of Japan	1	52
Kyoichi Murakami, Osaka, Japan.		
Illinois Central Railroad	23	4,296
A. W. Sullivan, Chicago, Ill.		
W. J. Harahan, Chicago, Ill.		
I. G. Rawn, Chicago, Ill.		
H. U. Wallace, Chicago, Ill.		
H. W. Parkhurst, Chicago, Ill.		
A. S. Baldwin, Chicago, Ill.		
C. Dougherty, Clinton, Ill.		
O. M. Dunn, New Orleans, La.		
R. B. Starbuck, Mattoon, Ill.		
J. C. Dailey, Freeport, Ill.		
F. B. Harriman, Chicago, Ill.		
D. S. Bailey, Rantoul, Ill.		
H. R. Safford, Chicago, Ill.		
F. H. Bainbridge, Chicago, Ill.		
Chas. Dunham, Chicago, Ill.		
P. Galvin, New Orleans, La.		
T. R. Cummins, Freeport, Ill.		
E. I. Rogers, Covington, Tenn.		
L. A. Downs, Clinton, Ill.		
H. R. Dill, Evansville, Ind.		
J. C. Gray, Cedar Falls, Iowa.		
C. W. Pifer, Chicago, Ill.		
L. C. Fritch, Chicago, Ill.		
International Railway of Buffalo	1	52
T. W. Wilson, Buffalo, N. Y.		
Jacksonville & St. Louis Railway	1	121
B. F. Bond, Jacksonville, Ill.		
Jacksonville & Southwestern Railway	1	90
Roland Woodward, Jacksonville, Fla		
Kansas City Belt Railway	1	52
G. M. Walker, Jr., Kansas City, Mo.		
Kansas City, Mexico & Orient Railway	3	365
E. Dickinson, Kansas City, Mo.		
M. P. Paret, Kansas City, Mo.		
W. W. Colpitts, Kansas City, Mo.		
Kansas City Southern Railway	2	762
A. F. Rust, Kansas City, Mo.		
C. H. Byers, Pittsburg, Kan.		
Kettle Valley Railway	1	42
H. W. Warrington, Grand Forks, B. C.		
Kohala & Hilo Railway	1	44
Robert Hawxhurst, Jr., Hilo, Hawaii Ter.		
Lake Shore & Michigan Southern Railway	4	1,416
E. A. Handy, Cleveland, Ohio.		
Samuel Rockwell, Cleveland, Ohio.		
F. E. Bissell, Cleveland, Ohio.		
R. O. Rote, Cleveland, Ohio.		

Name of Road and Membership.	Members.	Mileage.
Lake Erie & Western Railway	1	719
G. C. Cleveland, Indianapolis, Ind.		
Lehigh Valley Railroad	4	1,343
Walter G. Berg, New York, N. Y.		
E. B. Ashby, South Bethlehem, Pa.		
E. DB. Brown, New York, N. Y.		
F. E. Schall, South Bethlehem, Pa.		
Long Island Railroad	1	392
C. L. Addison, Long Island City, N. Y.		
Louisville & Nashville Railroad	1	3,543
R. Montfort, Louisville, Ky.		
Macon, Dublin & Savannah Railroad	1	92
J. T. Wright, Macon, Ga.		
Madras Railway	1	844
E. W. Stoney, Madras, India.		
Maine Central Railroad	1	821
B. W. Guppy, Portland, Me.		
Memphis & Gulf Railroad	1	
Seely Dunn, Memphis, Tenn.		
Mexican Central Railway	4	2,321
A. A. Robinson, New York, N. Y.		
E. E. Styner, City of Mexico, Mex.		
Lewis Kingman, City of Mexico, Mex.		
W. C. Bradley, Tampico, Mex.		
Mexican International Railway	4	849
C. T. Norton, Porfirio Diaz, Mexico.		
Rankin Johnson, Durango, Mex.		
F. W. Andros, Durango, Mex.		
C. J. Carroll, Durango, Mex.		
Mexican National Construction Company	1	89
A. P. Herbert, Colima, Mexico.		
Michigan Central Railroad	6	1,662
W. S. Kinnear, Detroit, Mich.		
G. H. Webb, Detroit, Mich.		
B. Douglas, Detroit, Mich.		
J. C. Mock, Detroit, Mich.		
D. L. Parker, Niles, Mich.		
T. H. Hickey, St. Thomas, Ont.		
Minneapolis & St. Louis Railroad	1	1,025
Iowa Central Railway.		
H. G. Kelley, Minneapolis, Minn.		
Minneapolis, St. Paul & Sault Ste. Marie Railway	2	1,522
E. Pennington, Minneapolis, Minn.		
J. J. Hankenson, Glencoe, Minn.		

Name of Road and Membership.	Members.	Mileage.
Mississippi Central Railroad	1	55
M. J. Epley, Hattiesburg, Miss.		
Missouri, Kansas & Oklahoma Railway	1	43
E. Holbrook, Coffeyville, Kan.		
Missouri, Kansas & Texas Railway	2	2,713
S. B. Fisher, St. Louis, Mo.		
L. Beauman, Oklahoma City, O. T.		
Missouri Pacific Railway	3	6,108
St. Louis, Iron Mountain & Southern,		
H. Rohwer, St. Louis, Mo.		
J. G. Hartigan, Little Rock, Ark.		
H. Devereux, Batesville, Ark.		
Mobile & Ohio Railroad	2	876
C. S. Clarke, St. Louis, Mo.		
C. F. Blue, Cairo, Ill.		
Moscow-Kursk Railway	1	692
Theo. Schidlovsky, Moscow, Russia.		
Muskogee Southern Railroad	1	
D. W. Bolich, Muskogee, I. T.		
Muskogee Union Railroad	1	
G. F. Morse, Muskogee, I. T.		
Nashville, Chattanooga & St. Louis Railway	4	1,200
J. W. Thomas, Jr., Nashville, Tenn.		
Hunter McDonald, Nashville, Tenn.		
G. D. Hicks, Tullahoma, Tenn.		
I. O. Walker, Paducah, Ky.		
National Railroad of Mexico	1	1,547
W. A. Hill, Saltillo, Mex.		
New York Central & Hudson River Railroad	6	2,881
W. J. Wilgus, New York, N. Y.		
H. Fernstrom, New York, N. Y.		
G. W. Vaughan, Buffalo, N. Y.		
P. G. Ten Eyck, New York, N. Y.		
Lawrence Griffith, New York, N. Y.		
A. B. Corthell, New York, N. Y.		
Nankai Railway	1	40
T. Endo, Osaka, Japan.		
National Railway of Tehuantepec	1	210
John B. Body, City of Mexico, Mexico.		
New York, Chicago & St. Louis Railway	4	523
A. W. Johnston, Cleveland, Ohio.		
E. E. Hart, Cleveland, Ohio.		
C. B. Hoyt, Bellevue, Ohio.		
A. P. Lagron, Lorain, Ohio.		

Name of Road and Membership.	Members.	Mileage.
New York, New Haven & Hartford Railroad	3	2,037
E. H. McHenry, New Haven, Conn.		
E. P. Dawley, Boston, Mass.		
W. H. Moore, New Haven, Conn.		
New York, Philadelphia & Norfolk Railroad	1	112
J. G. Rodgers, Cape Charles, Va.		
Nippon Railway of Japan	1	855
S. Sugiura, Tokio, Japan.		
Norfolk & Southern Railroad	1	192
F. L. Nicholson, Norfolk, Va.		
Norfolk & Western Railway	1	1,685
C. S. Churchill, Roanoke, Va.		
Northern Pacific Railway	2	5,305
Howard Elliott, St. Paul, Minn.		
E. J. Pearson, St. Paul, Minn.		
Northern Illinois Electric Railway	1	
A. M. Shaw, Dixon, Ill.		
Oregon Short Line	1	1,266
Wm. Ashton, Salt Lake City, Utah		
Pacific Electric Railway	1	
A. D. Schindler, Los Angeles, Cal.		
Pennsylvania Lines West of Pittsburg	7	2,672
Thos. Rodd, Pittsburg, Pa.		
W. C. Cushing, Pittsburg, Pa.		
R. Trimble, Pittsburg, Pa.		
Paul Jones, Columbus, Ohio.		
A. H. Sanford, Allegheny, Pa.		
E. G. Ericson, Pittsburg, Pa.		
A. A. Wirth, Pittsburg, Pa.		
Pennsylvania Railroad	4	5,064
J. T. Richards, Philadelphia, Pa.		
R. Bell, Buffalo, N. Y.		
A. H. Rudd, Philadelphia, Pa.		
W. S. Thompson, Oil City, Pa.		
Peoria & Pekin Union Railroad	1	20
Curtiss Millard, Peoria, Ill.		
Pere Marquette Railroad	7	2,108
M. J. Carpenter, Detroit, Mich.		
F. H. Alfred, Detroit, Mich.		
Job Tuthill, Detroit, Mich.		
G. H. Bristol, Detroit, Mich.		
G. E. Drew, Grand Rapids, Mich.		
Owen McKay, Walkerville, Ont.		
J. F. Deimling, Detroit, Mich.		

Name of Road and Membership.	Members.	Mileage.
Philadelphia & Reading Railway	4	1,466
Wm. Hunter, Philadelphia, Pa.		
F. S. Stevens, Reading, Pa.		
J. E. Turk, Tamaqua, Pa.		
C. H. Ewing, Reading, Pa.		
Philadelphia Elevated R. R. & Subway	1	
Chas. M. Mills, Philadelphia, Pa.		
Pittsburg & Lake Erie Railroad	4	184
J. A. Atwood, Pittsburg, Pa.		
A. R. Raymer, Pittsburg, Pa.		
Edwin F. Wendt, Pittsburg, Pa.		
E. W. Boots, McKeesport, Pa.		
Quebec Southern Railway	1	150
F. D. Anthony, Sorel, Quebec.		
Queen & Crescent	7	1,149
W. A. Garrett, Cincinnati, O.		
C. C. Harvey, New Orleans, La		
E. Ford, Vicksburg, Miss.		
J. C. Nelson, Birmingham, Ala.		
J. C. Haugh, New Orleans, La.		
H. M. Waite, Lexington, Ky.		
W. A. D. Short, Lexington, Ky.		
Richmond, Fredericksburg & Potomac Railway	1	89
E. T. D. Myers, Richmond, Va.		
St. Louis & North Arkansas Railroad	1	130
G. L. Sands, Eureka Springs, Ark.		
St. Louis & San Francisco Railway	4	3,742
A. J. Davidson, St. Louis, Mo.		
R. R. Hammond, St. Louis, Mo.		
C. D. Purdon, St. Louis, Mo.		
J. V. Hanna, St. Louis, Mo.		
Chicago & Eastern Illinois Railroad	3	727
W. S. Dawley, Chicago, Ill.		
A. S. Markley, Danville, Ill.		
Ralph McCalman, Danville, Ill.		
St. Louis, Brownsville & Mexico Railway (under construction).		
F. G. Jonah, Corpus Christi, Texas.		
San Francisco & Northwestern Railway	1	
H. C. Phillips, San Francisco, Cal.		
San Pedro, Los Angeles & Salt Lake Railroad	3	633
H. Hawgood, Los Angeles, Cal.		
E. M. Jessup, Los Angeles, Cal.		
H. M. McCartney, Salt Lake City, Utah.		
Santa Fe, Prescott & Phœnix Railway	1	303
W. A. Drake, Prescott, Ariz.		

Name of Road and Membership.	Members.	Mileage.
Sanyo Railroad	1	368
Junnosuke Yamaguchi, Kobe, Japan.		
Seaboard Air Line	3	2,611
W. W. Gwathmey, Jr., Portsmouth, Va.		
D. B. Dunn, Atlanta, Ga.		
W. I. Lee, Cedartown, Ga.		
Southern Indiana Railway	2	148
F. W. Ranno, Terre Haute, Ind.		
J. F. Cassell, Terre Haute, Ind.		
Southern Pacific Company	14	7,964
J. Kruttschnitt, Chicago, Ill.		
W. G. VanVleck, Houston, Texas.		
R. Koehler, Portland, Ore.		
Wm. Hood, San Francisco, Cal.		
J. H. Wallace, San Francisco, Cal.		
E. B. Cushing, New Orleans, La.		
J. A. Naugle, Guaymas, Mexico.		
J. D. Isaacs, San Francisco, Cal.		
T. Fitzgerald, Ogden, Utah.		
E. L. Swaine, Los Angeles, Cal.		
C. C. Mallard, Lafayette, La.		
G. A. Mountcastle, Tucson, Ariz.		
F. C. Miller, Sacramento, Cal.		
C. S. Corrigan, San Antonio, Texas.		
Southern Railway	4	7,195
C. H. Ackert, Washington, D. C.		
D. W. Lum, Washington, D. C.		
H. Baker, Greensboro, N. C.		
B. C. Milner, Louisville, Ky.		
Susquehanna & New York Railroad	1	66
C. A. Derr, Williamsport, N. Y.		
Tennessee Central Railroad	1	204
Alvah Philbrick, Nashville, Tenn.		
Texas Midland Railroad	1	125
L. W. Wells, Terrell, Texas.		
Toledo Railway & Terminal Company	1	34
T. F. Whittelsey, Toledo, Ohio.		
Union Belt Railway	1	22
H. G. Fleming, Memphis, Tenn.		
Union Pacific Railroad	9	2,956
J. B. Berry, Omaha, Neb.		
R. L. Huntley, Omaha, Neb.		
H. C. Ferris, Denver, Col.		
James Keys, Omaha, Neb.		
A. D. Schermerhorn, Omaha, Neb.		
A. K. Shurtleff, Omaha, Neb.		
C. C. Post, Jr., Omaha, Neb.		
John C. Beye, Kansas City, Mo.		
Ole Davidson, Omaha, Neb.		

Name of Road and Membership.	Members.	Mileage.
Union Railroad	1	57
E. C. Brown, Port Perry, Pa.		
Union Stock Yards & Railroad Company	2	50
Wm. J. C. Kenyon, South Omaha, Neb.		
W. S. King, South Omaha, Neb.		
Union Terminal Railway (of Sioux City)	1	16
B. S. Josselyn, Philadelphia, Pa.		
Vancouver, Victoria & Eastern Ry. & Nav. Co	1	
W. I. Barrett, Grand Forks, B. C.		
Vandalia Line	1	412
F. T. Hatch, Terre Haute, Ind.		
Victorian State Railways	1	3,113
Thos. Tait, Melbourne, Australia.		
Wabash Railroad	7	2,367
W. S. Newhall, St. Louis, Mo.		
A. O. Cunningham, St. Louis, Mo.		
E. K. Woodward, Detroit, Mich.		
A. G. Trippeer, Moberly, Mo.		
J. K. Howard, Peru, Ind.		
Edward Shelah, Moberly, Mo.		
W. W. Greenland, Decatur, Ill.		
Waterloo & Cedar Falls Rapid Transit Co	1	40
M. L. Newton, Waterloo, Iowa.		
Wellington & Manawatu Railway	1	84
James Marchbanks, Wellington, New Zealand.		
Western Pacific Railway	1	40
W. E. Condon, Quincy, Cal.		
Western Railways of Australia	1	1,355
Thos. Watson, Coolgardie, W. Australia.		
Wheeling & Lake Erie Railroad	1	462
J. E. Taussig, Canton, Ohio.		
Wisconsin & Michigan Railroad	7	72
B. C. Gowen, Peshtigo, Wis.		
Wisconsin Central Lines	2	881
C. N. Kalk, Milwaukee, Wis.		
A. H. Langdon, Fond du Lac, Wis.		
Consulting Engineers, etc	78	
Totals	453	184,550

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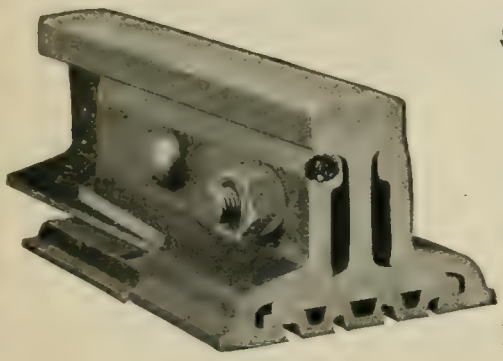

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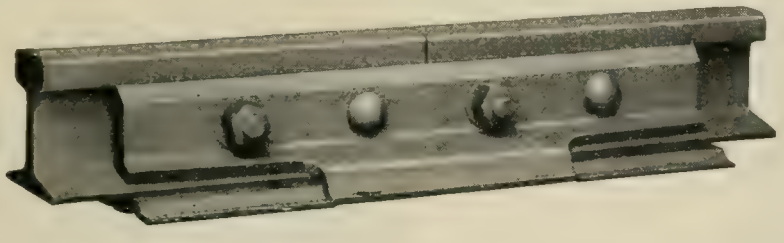

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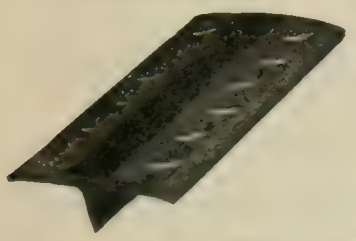

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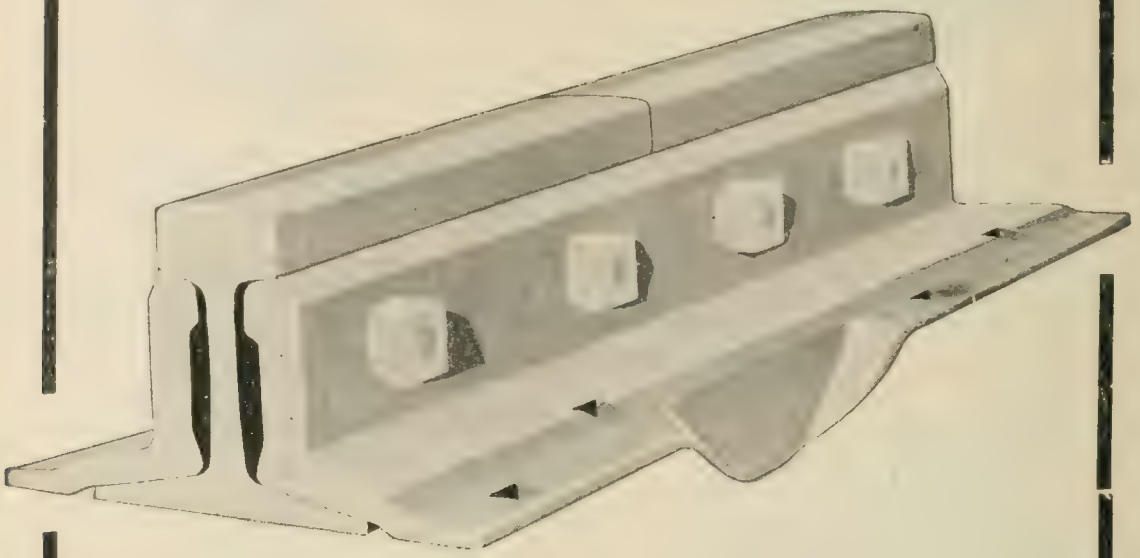

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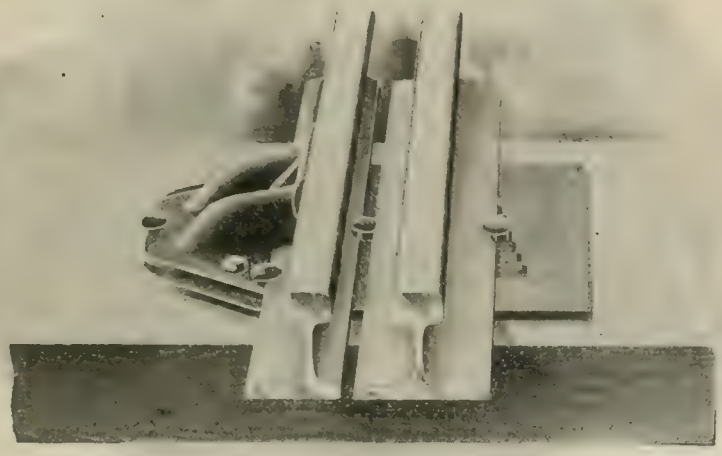

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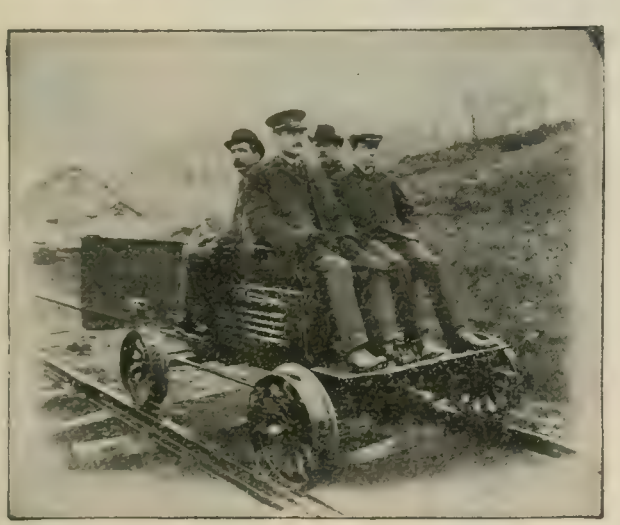

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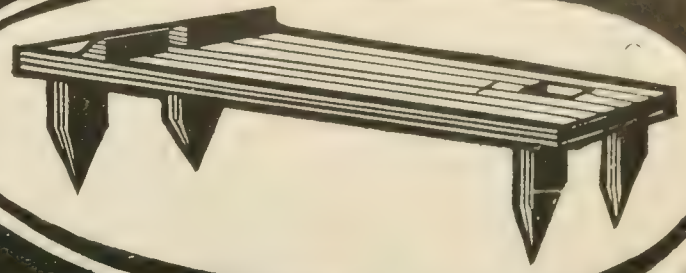

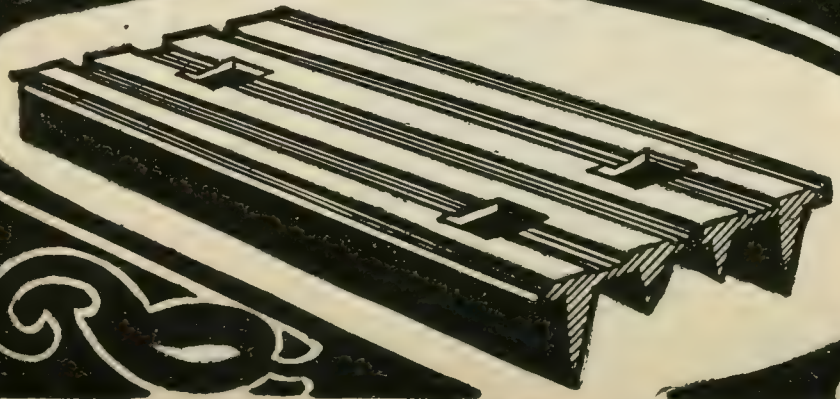

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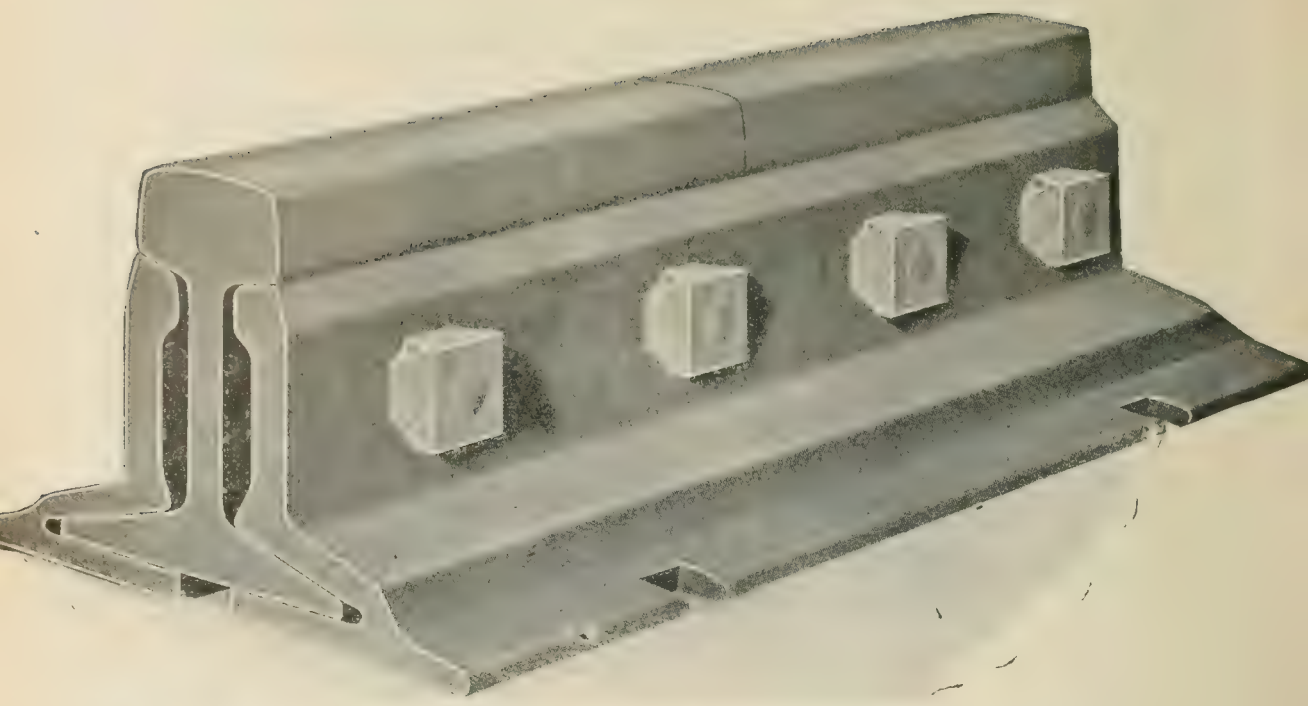

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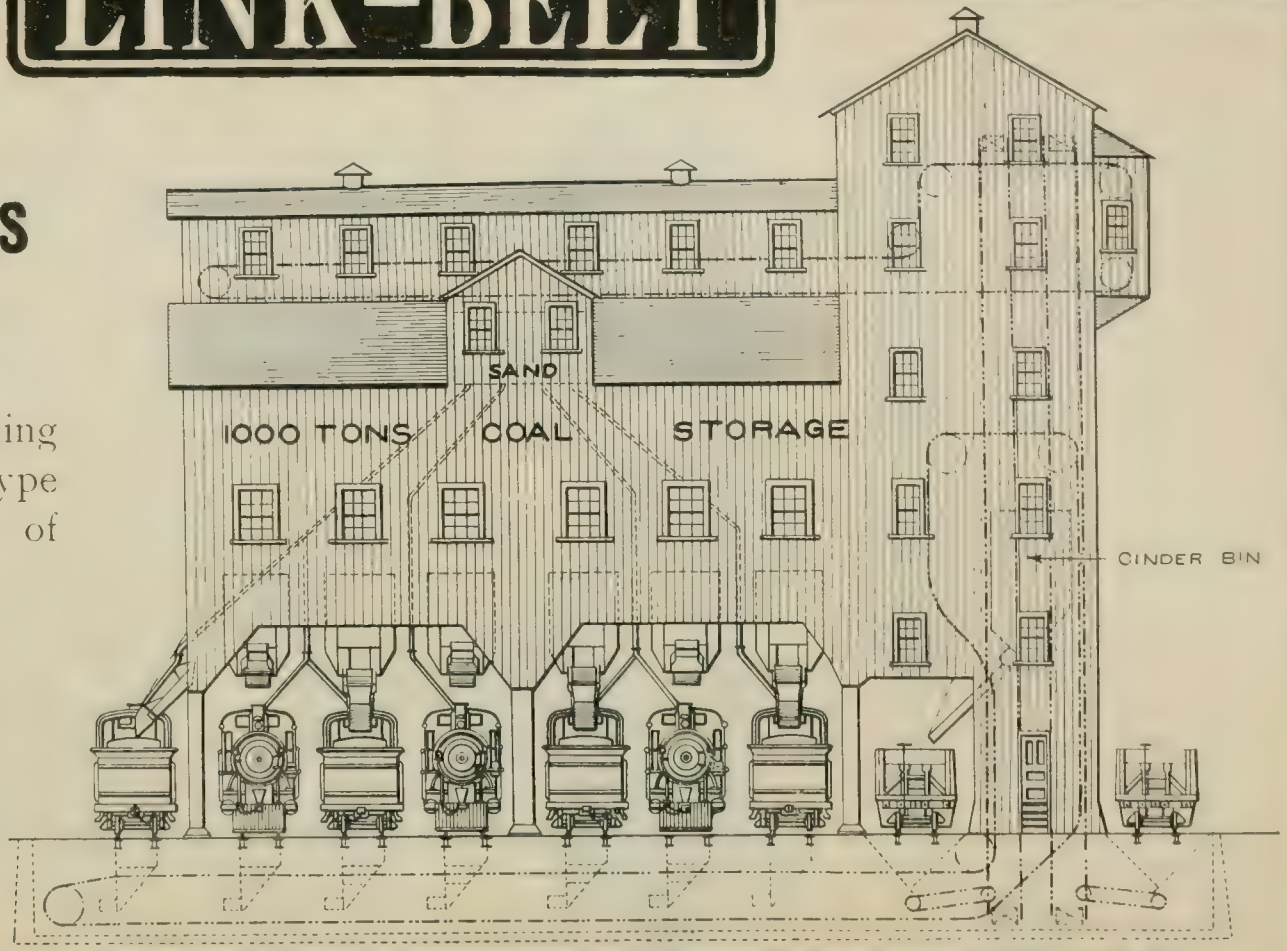

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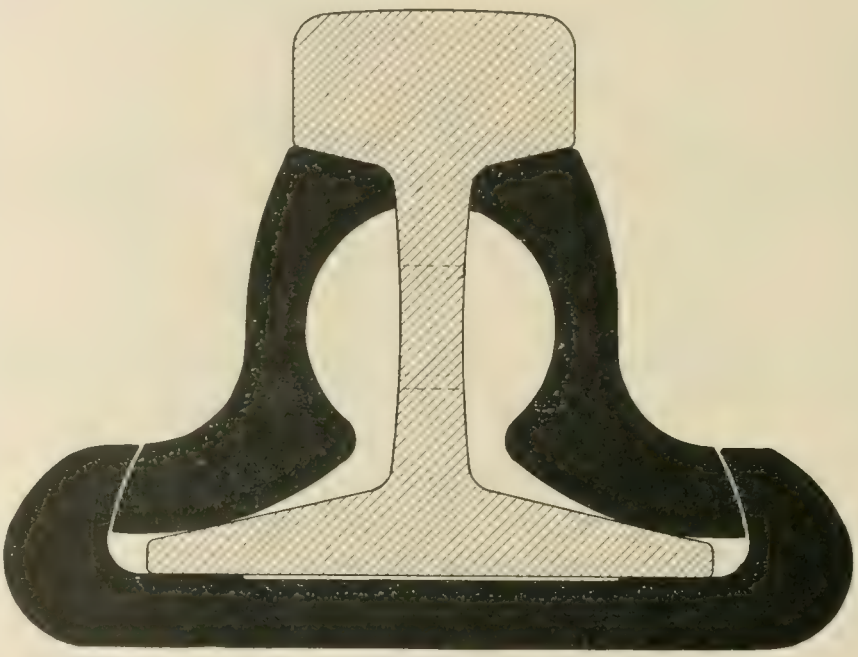

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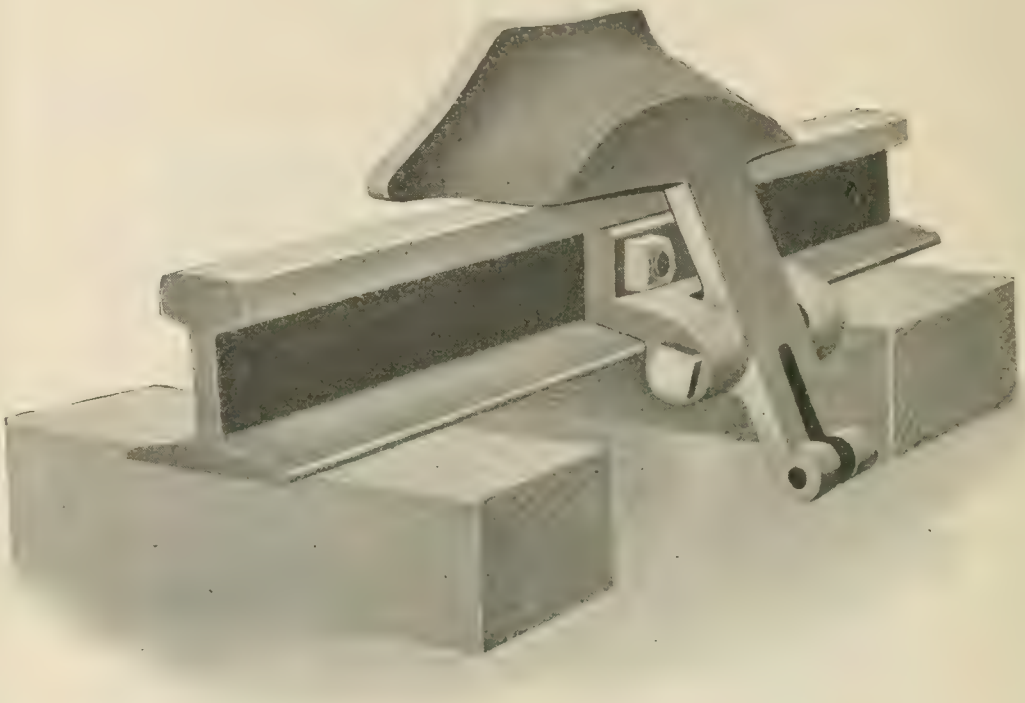

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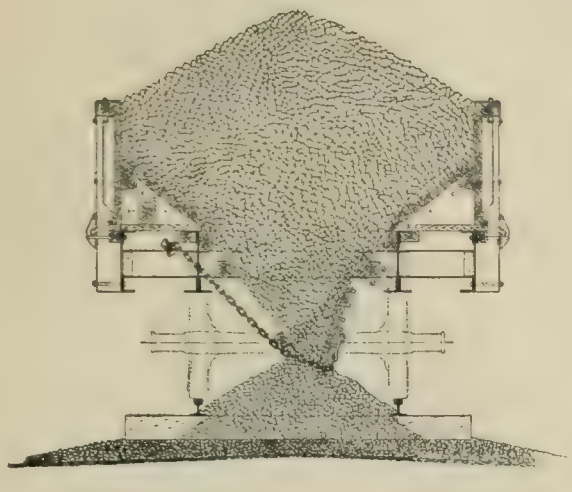

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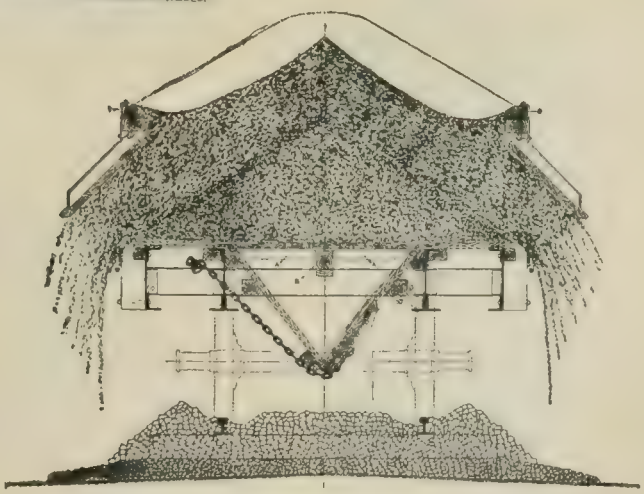

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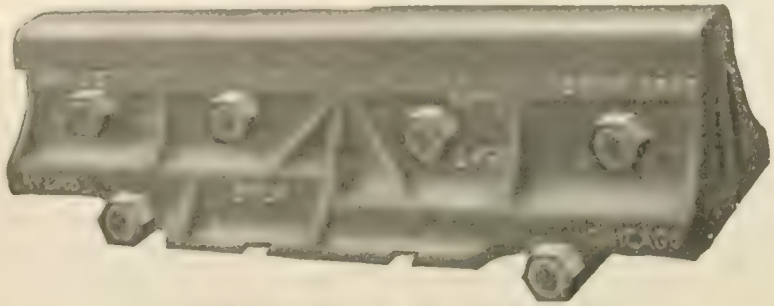

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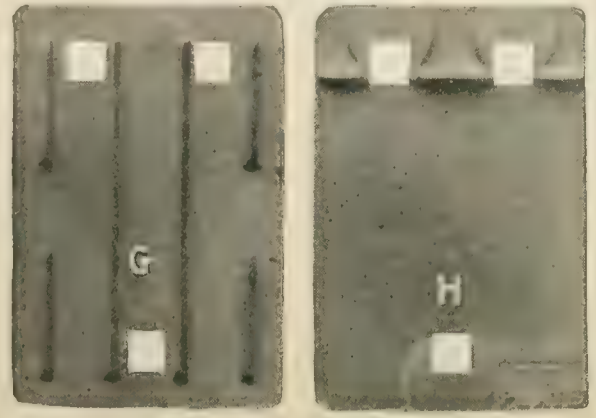

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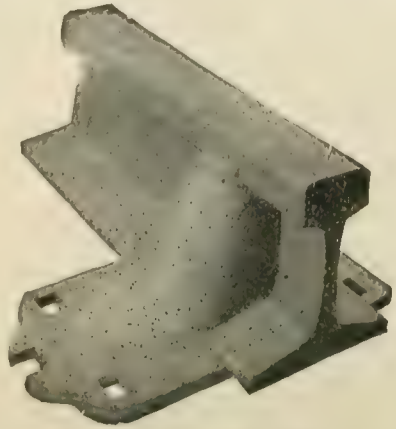

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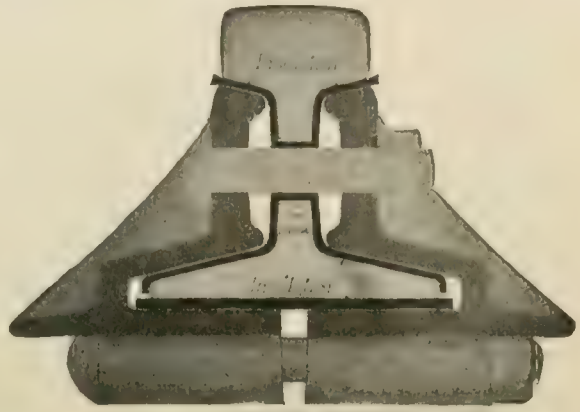

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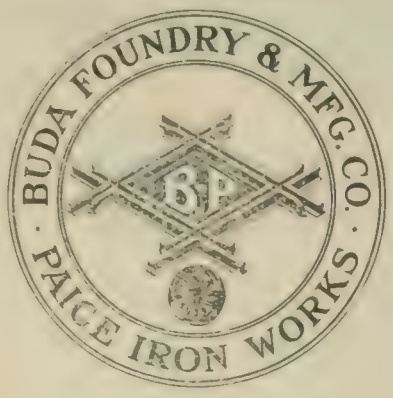

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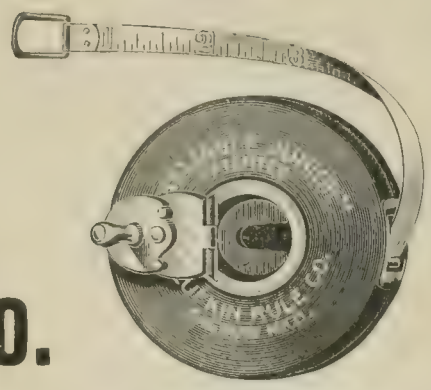

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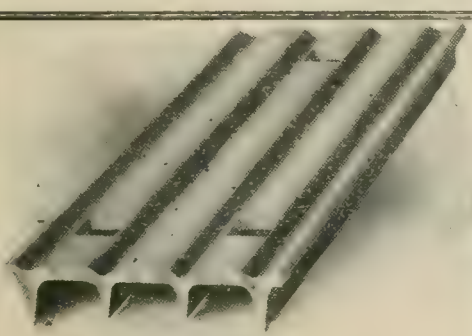

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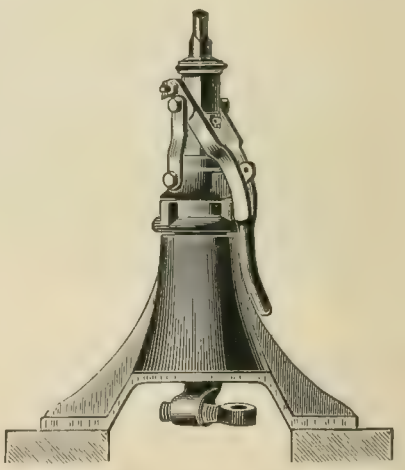

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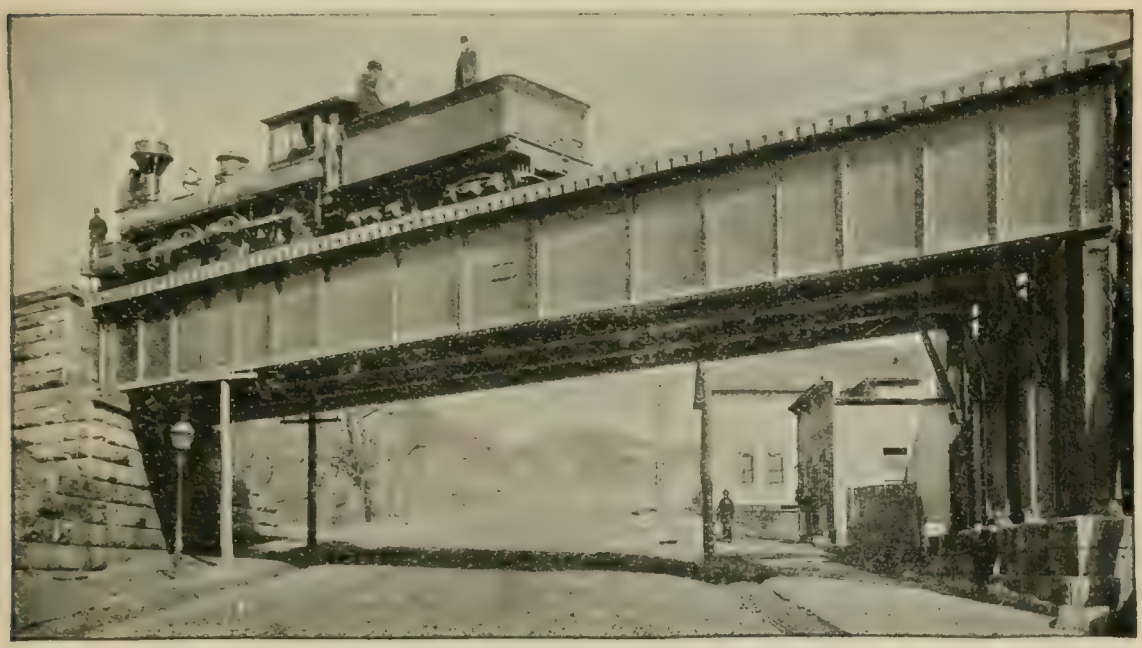

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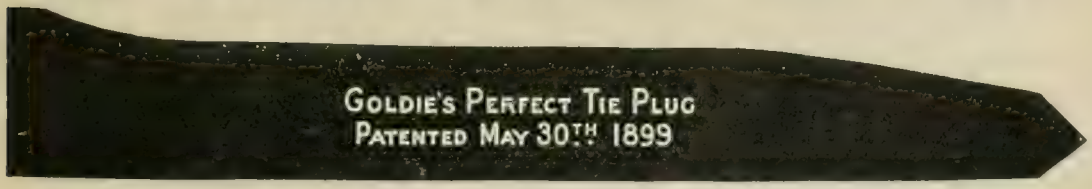

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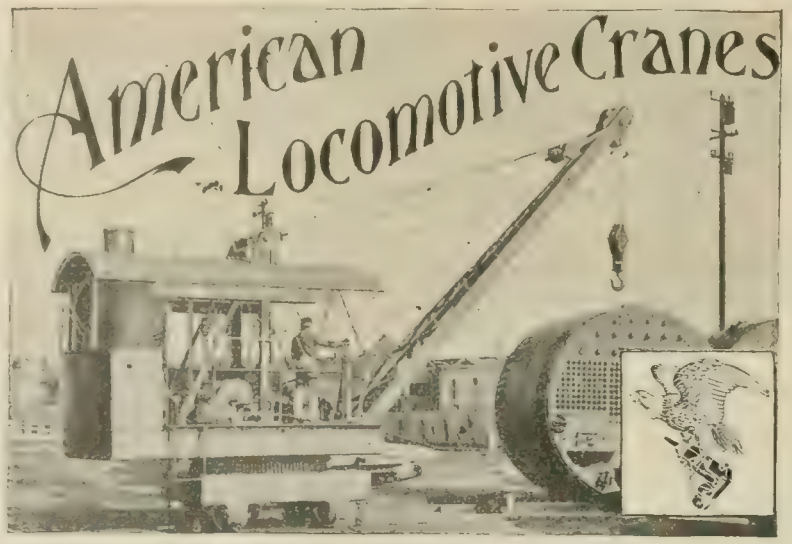

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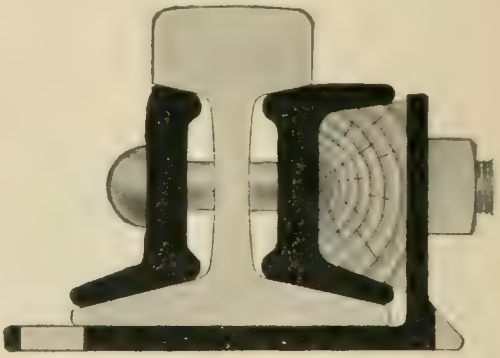

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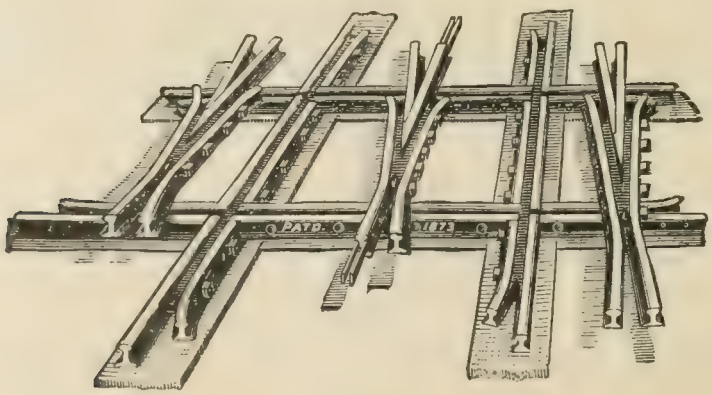

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